2012

Arizona's Strategic Plan for Digital Capacity

Full Report { Draft }

DIGITAL ARIZONA
COUNCIL

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Digital Arizona

{ Expanding Innovation Through Connectivity

ASET
Arizona Strategic Enterprise Technology

Digital Arizona
PROGRAM

Arizona's Strategic Plan for Digital Capacity
Report
NOTE: This is the Full Report version. The Summary and Expanded & Reference versions are available at: www.digitalarizona.gov/Digital_Arizona_Council/Strategy.html

Preface

Improving Arizona's digital capacity is critical to the future well-being of Arizonans. This is the first ever Arizona citizens' report on digital capacity.

Five citizen task groups drafted initial recommendations that were further developed by the Strategic Planning Task Group. Chair of this task group is Michele Norin, Chief Information Officer (CIO) for the University of Arizona. Ms. Norin is the winner of the CIO of the Year Award in 2011, given by the Arizona Technology Council.

The Strategic Planning Task Group reported out a draft to the Digital Arizona Council (DAC). The Counsel is chaired by Aaron Sandeen, State CIO and Arizona Department of Administration (ADOA) Deputy Director. Twenty Arizona citizens from diverse backgrounds who serve on the DAC, ultimately amended and voted to approve this report.

The Digital Arizona Council members recommend that this strategic plan be a living document. As such, it should be reviewed, changed and used over time.

Providing staff support for this effort is the ADOA's Arizona Strategic Enterprise Technology (ASET) office, under the direction of State CIO Aaron Sandeen.

Daily coordination was provided by ASET's Director of Digital Planning Michael Golden, industry technologist and thought leader in the area of advanced connectivity architecture; Galen Updike, former Arizona State Representative, who serves as Arizona's Broadband Development Manager, with Jeffrey Crane, serving as Project Manager.

ASET's office address is 100 N. 15th Ave. Suite 400, Phoenix, AZ 85007, and their main phone number is: (602) 542-2250

ASET's website is: http://aset.azdoa.gov/

The Digital Arizona Program's website is: http://DigitalArizona.gov/

The project's email address is: question@DigitalArizona.gov

ASET engaged Data-Site Consortium, Inc. to support the generation of this Broadband Strategic Plan and coordinate the gathering of stakeholder inputs and drafting of said document. The consulting team was led by Mark Goldstein and included Oris Friesen, Mike Keeling, and Brad Zerbe.

Disclaimer

This report is written by a citizens group of volunteers. None of the information in this report should be construed as official public policy of the Arizona State government. However, funding to assist in producing this report is from a federal grant managed by an Arizona State agency.

Digital Arizona
Turning IDEAS into ACTION!

Table of Contents

Arizona's Strategic Plan for Digital Capacity

Executive Summary

"In this 21st century economy, Internet access and jobs go hand-in-hand."
Governor Janice K. Brewer (Brewer, 2012)

Americans in the 21st century increasingly rely on high-capacity digital connectivity at ever-increasing speeds to engage, to compete, and to succeed in the global economy. Arizona's economic competitiveness demands that affordable digital capacity be available to all of its communities and citizens. Far too many Arizonans do not have access to, cannot afford, or do not use high-capacity digital services today. **It is the mission of the Digital Arizona Council to turn this "digital divide" into a "digital opportunity."** Enabling all Arizona residents and institutions to realize their potential in the Information Age is certainly one of the State's most significant challenges this century.

Digital capacity encompasses the physical plant for high-speed access to the Internet and advanced digital services, as well as a broad range of digital end-user equipment such as computers, smart phones, tablets, and entertainment devices. This digital infrastructure will be as important to the economy and quality-of-life of Arizona residents in the 21st century and beyond as other essential infrastructures such as electric power, water, and highways have been in the past. Advancing our digital infrastructure will be fundamental to progress in every area of society including education, healthcare, research, business, public safety, government and the environment.

Census data reveals Arizona ranks 18th in coverage among the states and District of Columbia with 79.1% of Arizonans living in households with Internet access and ranks 31st in individuals accessing the Internet at home at 64.6%. In another study, Arizona ranks 34th among the fifty states in average digital connection speeds. In a letter to Arizona State legislators, Arizona Department of Education Superintendent John Huppenthal stated that the minimum speed required to support their education transformation plans is 6 megabits per second per student at school and at home. However, this Internet service speed offering is only available to 72% of rural areas and 57% of sparsely populated rural areas in the State. Until this deficit is corrected in rural areas, statewide plans for educational transformation cannot be fully implemented.

There are major barriers to overcome for rural Arizona's digital buildout. These include the costs and delays in permitting processes, lack of consistent rules among jurisdictions, inadequate long-distance connections (middle mile) infrastructure, and lack of network resiliency. Digital service providers need help from state and local governments in reducing regulatory barriers and leveraging state and regional government owned assets to motivate and justify their investments in rural Arizona, where there is less population density and fewer potential customers. Toward this end, the Governor recently signed into law the landmark Digital Arizona Highways Act of 2012, allowing conduit for fiber optics to be built along Arizona's highways using State rights-of-way. The Arizona Strategic Enterprise Technology Office through the Digital Arizona Program outlined in this strategic plan is analyzing the potential for using this system and possible mechanisms for its funding and implementation. This is an important first step in realizing an Arizona digital capacity infrastructure strategy.

Creating Arizona's leading-edge digital infrastructure for the 21st century is a task that must be shared by government, industry, educators, researchers, first responders, community institutions, entrepreneurs and philanthropists. Together, these stakeholders should implement a comprehensive plan consisting of the following ten recommendations:

DIGITAL BUILDOUT - Facilitate the buildout of high-speed digital infrastructure by the private sector in cooperation with government entities (at all levels) to provide for the needs of all Arizonans

INCREASE ADOPTION - Increase the use and adoption of high capacity digital connectivity and technologies

LEADERSHIP MATTERS - Formalize and sustain state-level and regional digital leadership

PLANNING AND ECONOMIC DEVELOPMENT ARE CRITICAL - Drive digital-related local community planning and economic development

OUTREACH - Drive community outreach through policies, programs, and local engagement

EDUCATION AND JOB READINESS – Facilitate the implementation of underlying technologies, digital curricula, collaboration, and professional development to promote improvements in education and workforce development

IMPROVE HEALTHCARE – Facilitate the expansion of a robust statewide telehealth ecosystem

ADVANCED RESEARCH - Catalyze and enable an environment of discovery, innovation and research

PUBLIC SAFETY COMMUNICATION - Support and align with the public safety community in enhancing and leveraging operations and communication capabilities

ENERGY AND THE ENVIRONMENT – Support the leveraging of digital capacity to reduce/optimize energy consumption and protect the environment.

This document contains detailed actions that will enable each of the above recommendation areas of the plan to be accomplished.

In this strategic plan, we envision the long-term benefits of digital capacity development for the State of Arizona. It will transform education, healthcare, and research, improve public safety and government operations, create major new opportunities for business and employment, reduce energy consumption and protect the environment, and enable a long-term future of sustainable economic development. We have emphasized the most cost-effective, flexible approaches to build this digital capacity infrastructure. Arizona needs to remove barriers and develop public policies and market-driven strategies that encourage private-sector investment to provide cost-effective high-speed broadband Internet access and advanced digital services throughout the State. Our primary strategy is to enable the private sector to provide the digital infrastructure and services, but government and alternative funding should be considered where the private return on investment is not sufficient for this to occur.

We believe the long-term benefits to the state and nation will greatly outweigh the costs of the required digital infrastructure. The Digital Arizona Program will create models to quantify the long-term benefits and costs for sample rural communities in the near future. Given that these statewide and national benefits are critical to our future, we believe there is a strong case to be made for state and federal government assistance in supporting communities in developing the required digital capacity infrastructure and corresponding services. This will be an investment in Arizona and the United States that will yield immense societal returns for current and future generations.

Digital Arizona Council (DAC) Strategic Plan Task Force Letter

Dear Fellow Arizonans,

The Arizona Strategic Plan for Digital Capacity is the product of many volunteers. They represent a diverse cross section of your fellow citizens. Their interest is in the future of Arizona's digital capacity for the betterment of all Arizonans.

Together this document represents a consensus viewpoint.

The Arizona Strategic Plan for Digital Capacity is approved by the Digital Arizona Council in the final form you see here. It is a strategic roadmap for the future of digital capacity in Arizona. This is a living document that will be monitored, changed and adapted to meet the digital needs of Arizonans.

This report takes into account the Governor's Four Cornerstones of Reform, the Governor's P20 Council Arizona Education Reform Plan, and Arizona's Statewide Strategic IT plan, plus the Governor's recently signed Digital Arizona Highways Act of 2012. This report aligns with these other goals and reforms.

When creating a report, it is not unusual to have different views from diverse interests. However, this report received a great deal of equanimity and consensus from those who participated in its creation, and those who voted to adopt it.

All agreed that development of digital capacity in Arizona is key to Arizona's future. Having access to adequate digital capacity for all Arizonans is vital. Capacity and speed of the digital systems in our State are decisive factors in success with this incredible tool.

Success is measured by how Arizona's digital capacity is used creatively in Arizona's private sector, government, economic development, education, healthcare, public safety; and in the "pursuit of happiness" by our fellow Arizona citizens.

The Digital Arizona Council

Acknowledgements

The DAC thanks the many Arizona volunteers who served on various task forces and Arizona's State employees who contributed and helped make this strategic plan possible.

Six task groups with some 70 participants gave their time to help. Without the assistance of these volunteer citizens this first ever Arizona citizen digital report would not have been possible.

The DAC provides governance, advice, and balanced representation for Arizona's diverse Digital Stakeholders, for the Digital Arizona Program (DAP).

The Council includes twenty one member positions with seven positions from each of three diverse groups.

The digital provider category includes Incumbent Local Exchange Carriers (ILECs), cable companies, cellular/LTE, fixed wireless, satellite, wholesale backhaul, urban and rural representation.

In the business/community citizen category there are representatives from healthcare, education, manufacturing, tourism, retail, and rural, urban and tribal communities.

Government representatives include State agencies as customers and as policy makers; plus local governments as customers and as policy makers. The members of the DAC are:

- Aaron Sandeen, State CIO and ADOA Deputy Director (DAC Chairman)
- Michael Bernstein, Co-Founder, Simply Bits, LLC
- Honorable Robert Burns, Former Arizona State Senate President
- Teri Drew, Regional Director, Northern Arizona Council of Governments
- Jodie Filardo, Community & Economic Development Director, Town of Clarkdale
- Jeremy Graves, Chief Operating Officer, Marketing & Sales, Valley Telecom Group
- John Halikowski, Director, Arizona Department of Transportation
- John Huppenthal, Arizona Superintendent of Public Instruction, Department of Education
- Michael Keeling, President, Data-Site Consortium, Inc.
- Tom McCloud, Director, DHG Manufacturing, Intel Corporation
- Michele Norin, Chief Information Officer, University of Arizona
- Alan Pitt, MD, Neuroradiologist, Barrow Neurological Institute
- Leroy Shingoitewa, Chairman, Hopi Tribe
- Kenneth Mcmahon, VP/General Manager-Phoenix, CenturyLink, Inc.
- Hyman Sukiennik, Vice President, Cox Business Arizona, Cox Communications
- Craig Sullivan, Executive Director, County Supervisors Association of Arizona
- Kelly Udall, Town Manager, Town of Pinetop-Lakeside
- Daman Wood, Vice President, Wholesale Markets, Airband
- Emerson Yearwood, Assistant General Counsel, Regulatory Affairs, Cable One, Inc.
- Steven Zylstra, President & CEO, Arizona Technology Council

Digital Capacity is the Foundation for Arizona's 21st Century Economy

Arizona celebrates its centennial this year. Major infrastructure projects were key to Arizona's first century of growth, including the Hoover and Roosevelt Dams, the Central Arizona Project, railroads, and the interstate highway system. Arizona's digital capacity infrastructure will be as important to the economy and quality-of-life of Arizona residents in this century and beyond as other essential infrastructures, such as electric power, water, and transportation were in the past. The building of roads, highways, and railroads fostered commerce, international trade, and jobs; so, too, does this new information superhighway as it processes and moves information 24 hours a day, with a capability and speed dictated only by the capacity of the digital infrastructure. Advancing our digital infrastructure will be fundamental to progress in every area of society including education, healthcare, research, business, government, public safety, agriculture, energy and the environment.

The term "Digital Capacity" refers to high-speed (often called broadband) wireline and wireless access to the Internet and a broad range of digital end-user equipment, which together form the digital capacity infrastructure. Advanced digital services provided to consumers beyond basic internet service include mechanisms that guarantee quality of service and security. Advanced digital capacity also provides support for content delivery to improve user experiences in viewing Web sites, video streams, conferencing and collaboration services. Digital end-user equipment includes computers, servers, local area networks, supercomputers, tablets, smart phones, smart electric meters, smart appliances, digital cameras, entertainment devices, and sensors.

Competing and succeeding in the 21st century global economy requires Arizona to deploy and expand digital capacity that delivers high-capacity connectivity to all its communities and citizens. Yet, far too many Arizonans either do not have access to, cannot afford, or do not use high-capacity digital services today.

There are two primary infrastructure components in network services required to deploy broadband into a community - last mile and middle mile. Middle mile is the means by which high capacity connections are delivered to a community. The last mile is the capacity that is available within a community.

If a shared middle mile infrastructure is not available at reasonable rates, communities, or last mile providers, must construct their own middle mile infrastructure. This increases overall costs that can significantly increase the end users' monthly rates. Due to recent advancements in wireless, and other technologies, last mile deployment of broadband is becoming more cost-effective, even in unserved and poorly served areas of the state with sparse populations. A number of companies have expressed interest in providing last mile service in these areas. In order to deploy their networks, and charge reasonable rates, they must have access to sufficient and reasonably priced middle mile connections.

Major barriers to rural Arizona's Digital buildout include the costs and delays in construction permitting processes, lack of consistent rules among multiple jurisdictions, inadequate long distance backhaul (called middle mile) infrastructure capacity, and lack of network connectivity redundancy. Broadband providers report that the cost of obtaining permits and delays in approvals are significant barriers to digital capacity investment and deployment. Such excessive delays and costs reduce the return on investment (ROI) for the private providers in our state; especially in rural Arizona where there is less population density and fewer potential customers. (FCC, 2010, p. 131)

Arizona also lacks wide area interconnected fiber-optic rings to create robust statewide digital connections. Many communities are essentially stranded islands of digital capacity lacking fail-safe redundancy and inadequate backup in emergencies. There have been numerous Arizona

communities that have experienced prolonged broadband Internet and 9-1-1 outages resulting in millions of dollars in economic damage. Ideal digital infrastructure is constructed in rings or interconnects so if there is a cut in the line, the system can route traffic in other directions. (Data Site Consortium and International Research Center, 2009, p. 50)

It is the mission of the Digital Arizona Council (DAC) to turn this "digital divide" into a "digital opportunity". Enabling all Arizona residents, educational institutions, libraries, healthcare providers, public safety jurisdictions, businesses and government agencies to realize their potential in the Information Age may be the State's most significant challenge this century.

How Will Digital Capacity Availability and Use Impact Arizona?

About 680,000 Arizonans live in rural areas (US Census Bureau, 2010). Without adequate digital capacity in parts of rural Arizona, students there will continue to have many fewer educational opportunities than urban students. Young people, bored and frustrated by the inadequate digital systems that cannot run their applications, will seek a future elsewhere. Business opportunities and jobs will be limited. Rural healthcare will continue to suffer.

With expanded digital capacity, rural businesses will not be limited to customers just in their area, but can sell on the Internet and address a national and global market. Businesses that require robust digital capacity to operate could locate in rural Arizona, creating new jobs. Advanced uses of telemedicine in rural Arizona healthcare facilities could provide enormous benefits with the availability of infrastructure for healthcare messaging, health monitoring and health collaboration. Telemedicine can reduce patient travel costs and time, provide an additional revenue sharing stream for financially-struggling rural hospitals, give immediate access to additional emergency and specialty care from medical experts in other locations, speed up medical records transmission, transmit x-rays for quicker results, provide remote diagnosis and treatment, improve the quality of care and save lives.

Improved digital capacity for Arizona opens up a world of educational opportunities for Arizona's school children. These include satisfying the Common Core Assessment requirements, online tutoring and e-learning systems for individualized instruction at a student's own pace in school or at home. Other education opportunities include distance learning with experts in other locations, collaboration between urban and rural schools, live remote field trips to places all over the world, online academic competitions and interactive exchanges with students in other locations.

Digital infrastructure benefits extend beyond schools to higher education, libraries, and research institutions. For example, libraries can become centers of excellence in job search for the unemployed. Advanced research and development in healthcare, biology, aerospace engineering, science, and national security will be enabled by the capability to transmit massive amounts of data through interconnecting high-performance computer networks.

Government operations will become more accessible and effective for all Arizona citizens. More and more government services will be offered online. The Arizona Department of Administration's (ADOA) Arizona Strategic Enterprise Technology (ASET) Office operates the State's web portal and has the bold goal to eventually provide to all Arizona citizens online digital government services that are "available anywhere, at any time, to every Arizonan." (ASET, 2012) Public safety will be improved by enabling interoperability of voice, data and video communications among all first responders to emergencies such as forest fires and life threatening accidents. Law enforcement will be enhanced with high-speed remote access to data communications capabilities. To make these goals a reality, Arizona needs world-class digital connectivity.

Advanced digital infrastructure can enable Arizona to move along the path of sustainable economic

development reducing energy consumption and protecting the environment for current and future generations. It will allow individuals and organizations to substitute telecommunications for travel via telework, distance learning, teleshopping and e-commerce, remote healthcare practices, and e-government. "American families can save nearly $8,000 a year on entertainment, travel, housing, automotive and other costs by using broadband Internet connectivity, according to data issued by the Internet Innovation Alliance" (Engebretson, 2010). The electric power network can be modernized to become a smart grid that effectively uses renewable solar and wind sources for power generation, optimizes electric power consumption by end users and makes possible the mass deployment of electric and hybrid electric vehicles.

This document explains the broad range of benefits for education, healthcare, research, economic development, public safety, government operations, energy and the environment that could be realized with an advanced Arizona digital capacity infrastructure.

Arizona's Digital Networking Capacity Gap

Individuals and organizations are continually demanding higher-speed and higher-capacity networking access over time for running more advanced applications and to achieve better performance. For example, an Apple iPhone 4s requires three times the amount of bandwidth as an Apple iPhone 3. A rural hospital can evolve from e-mailing X-rays and Magnetic Resonance Imaging (MRI) scans to providing services to local patients from specialists at an urban hospital through telepresence video-conferencing.

The Federal Communications Commission's (FCC) National Broadband Plan (FCC, 2010) uses a legal definition for broadband Internet access based on minimum upload and download speeds. These broadband speed definitions and requirements, beginning in Kilobits per second (Kbps) and moving to Megabits per second (Mbps), increase dramatically over time.

- *1999 definition: 200 Kbps download, 200 Kbps upload*
- *2012 definition: 4Mbps download, 1Mbps upload*
- *2015 definition: 50 Mbps download, 20 Mbps upload*
- *2020 definition: 100Mbps download, 50 Mbps upload* (FCC, 2010, p. 9)

Thus, in 2020, the National Broadband Plan goal for the speeds to meet the definition of broadband access, compared to the 1999 definition, will be 250 times greater for upload speeds, and 500 times greater for download speeds. Clearly, a flexible, cost-effective digital infrastructure strategy must be developed to keep pace with these rapidly-rising digital networking capacity requirements.

New census data reveals:

- Arizona ranks 18th among the 50 states and the District of Columbia in coverage with 79.1% of Arizonans living in households with Internet access.

- Arizona ranks 31st in individuals accessing the Internet at home at 64.6%.

- Arizona ranks 15th in Individuals with a household computer at 84.2%.

- Finally, Arizona ranks 24th with 40.4% of individuals in the state having access to the Internet from a location outside their home. (US Census Bureau, 2010)

Arizona's own broadband data collection through the National Telecommunications and Information Administration (NTIA) grants yield significant real-world data. For an Internet connection speed of 6

Mbps download, the download speed recommended by the Arizona Department of Education (ADE) for its education transformation plans, the service availability percentages for households is only 72% for rural areas, and only 57% for sparsely populated rural areas, leaving some 43% of households in sparsely populated rural areas without such higher-performance services. See Appendix A of the Expanded & Reference version for more detailed analyses.

Akamai Technologies gives another view using data gathered across its global server network, which serves an estimated 20% of the world's Internet traffic, to provide continually-updated visualizations of global Web traffic and performance. In their most recent reporting for Q2 2012;

- Arizona ranks 45th among the 50 states and the District of Columbia with a 4.8 Mbps average speed experienced by broadband subscribers.

- For average peak speed, Arizona ranks 48th with 19.7 Mbps.

- For overall broadband adoption of over 4 Mbps, Arizona ranks 44th with 43% of the population utilizing such services realizing a 24% increase in subscribership from 35% in Q3 2007.

- For high broadband adoption over 10 Mbps, Arizona ranks 43rd with 8% of the population utilizing such services realizing a 135% increase in subscribership from 6% in the last year and a 450% increase from 2% in Q3 2007.

Further details and comparisons can be found in Appendix A of the Expanded & Reference Version.

From another study:

- Arizona currently ranks 34th among the fifty states in average digital connection speeds.

Among our neighbors:

- California ranks 8th

- Nevada 9th and

- Utah ranks 2nd. (Woolley, 2011).

The current NTIA Broadband Mapping grants run through 2014 and it remains uncertain whether any federal support for the states' efforts will be provided after that. So, if Arizona wishes to continue with its broadband data collection, mapping and analysis efforts after that time, plans must be put in place and resources found to support its continuation.

Rural Digital Capacity Buildout: Digital Arizona Highways Act of 2012

There are major barriers to overcome for rural Arizona's digital buildout. These include the costs and delays in permitting processes, lack of consistent rules among jurisdictions, inadequate long-distance connections (middle mile) infrastructure, and lack of network capacity resiliency. Digital service providers need help from Arizona state and local governments in reducing regulatory barriers and leveraging state and local government-owned assets to motivate their investment in rural Arizona, where there is less population density and fewer potential customers.

Toward this end, Governor Jan Brewer recently signed into law the landmark Digital Arizona Highways Act of 2012, allowing conduit for fiber optic cables to be built along Arizona's highways

using State rights-of-way. Now Arizona's legal definition of transportation, within rights-of-way of Arizona's highways, includes transport of information as well as vehicles (Arizona Council of Engineering Companies of Arizona, 2012). (Arizona State Senate, 2012) (Arizona State Legislature, 2012) This legislation essentially creates "two highways for (nearly) the price of one." The cost to lay fiber conduit along highways is approximately the same order of magnitude as the cost to paint the stripes on the highway (ASET, 2011). However, in support of the intent of the Digital Highways Law, the Arizona Department Of Transportation (ADOT) is encouraged to review its rules regarding where and how fiber-conduit might be deployed along it's rural highway rights-of-way for the purpose of facilitating and lowering conduit construction costs within the context of reasonable safety standards and federal rules to accelerate rural fiber conduit build-outs. Many other state DOTs have identified multiple ways to safely and creatively accelerate build-outs in rural highway rights-of-way.

The ASET Office through the Digital Arizona Program (DAP) is analyzing the potential for using this system and possible mechanisms for its funding and implementation. This is an important first step in realizing an Arizona digital capacity infrastructure strategy. It enables private-sector deployment of middle-mile infrastructure to reach rural communities in a cost-effective manner, and the fiber-optic cables provide the flexibility for virtually unlimited amounts of capacity to support any future networking applications. Last mile connectivity to end users in rural communities also needs to be addressed. A cost-effective, flexible proposal for this includes multiple-use cell towers that transmit high-capacity microwave beams to major end-user sites, such as schools, libraries, hospitals and other Internet Service Providers (ISPs). The towers can be shared for other applications including public safety (possibly in the new federal government FirstNet network) to reduce costs.

The State of Arizona is not in the business of competing with the private sector and has long held to the tenet of being an anchor tenant or reliable customer to suppliers and providers of broadband. Such a customer relationship can help a provider justify private investment and the extension of service portfolios to rural and higher business risk areas. In fact, certain kinds of State participation in the telecom business and granting of State assets are prohibited by the gift clause provisions of the Arizona Constitution (Arizona State Constitution, 1912). Arizona does not want to subsidize business, but rather to facilitate and support business and be its reliable partner and customer in the telecommunications and broadband arena.

Complementary to the Digital Arizona Highways Act of 2012, a recent federal Executive Order will allow and enable broadband construction that is up to 90 percent cheaper and more efficient along Federal roadways and properties. Currently, the procedures for approving broadband infrastructure projects on properties controlled or managed by the Federal Government, including large tracts of land, roadways and more than 10,000 buildings across the nation, vary depending on which agency manages the property. This new Executive Order will ensure that agencies charged with managing Federal properties and roads take specific steps to adopt a uniform, simplified, and accelerated approach for allowing broadband carriers to build networks on and through those assets and speed the delivery of connectivity to communities, businesses and schools. (Office of the White House, 2012)

A Comprehensive Plan for Arizona's 21st Century Economy Based on Digital Infrastructure

The DAC believes that Arizona's stakeholders will need to achieve the following objectives:

Provide sufficient ubiquitous digital capacity to Arizona's citizens and institutions to support common applications available at any specific point in time, while recognizing that future digital demand will increase exponentially over time.

Provide ultra-high bandwidth digital capacity for advanced research in areas of demand such as in and around research universities and institutions.

Increase adoption and use of digital broadband by those who cannot afford it, do not have access to digital capacity in a public place, or who need training in how to utilize the opportunities available through the Internet including research for job opportunities, making employment applications and job training.

Enable and facilitate the private sector to provide more digital capacity to rural Arizona by leveraging State assets, unlike other states that have built state-owned networks that compete with the private sector.

To meet these objectives, public and private-sector stakeholders should undertake a comprehensive plan that will establish the foundation for Arizona's 21st century economy. Creating Arizona's leading-edge digital infrastructure for the 21st century is a task that must be shared by industry, government, educators, healthcare providers, first responders, researchers, community institutions, entrepreneurs and philanthropists. Together, these stakeholders should adopt and implement the following strategic plan consisting of ten recommendations. This strategic plan contains detailed descriptions and multiple specific actions that will enable each of the ten recommendation areas of the plan to be accomplished.

We conclude this strategic plan with a discussion of next steps. This includes the establishment by the ASET's Digital Arizona Program (DAP) of sample rural community models to demonstrate the broadband networking applications and quantify the long-term benefits and costs. We summarize the actions required from various responsible organizations to execute this plan. We also discuss the federal government, state government, and private sector funding options that must be considered to realize the full implementation of this plan, which will yield immense returns for current and future generations in Arizona and the United States as a whole. Important public funding sources and options to consider are: expanding the federal government eRate program for telecommunications services and digital equipment for schools and libraries, creatively using federal FirstNet public safety assets to support a mutually beneficial cost-effective buildout of rural digital infrastructure, using the State's universal service and reforming the federal universal service fee on telecommunications services to build the state and nation's next-generation digital infrastructure and rewarding electric utility companies that use emerging energy-saving broadband technologies. It is important to involve stakeholders in a consensus based approach when evaluating these options.

Achieving the benefits that digital capacity will produce requires Arizona to adopt aggressive goals that in turn drive commitments and action. The recommendations in this report will serve as a roadmap and underlying mechanisms for rapidly expanding broadband in unserved and poorly served areas of the state; innovate new applications; increase awareness about broadband; and ensure that Arizonans have the resources and skill to take advantage of abounding digital capacity. Securing and maintaining Arizona's global leadership requires a vision and commitment to digital capacity goals and tasks that need be shared by government, entrepreneurs, philanthropists, industry, educators, researchers, and community institutions.

A call to action….

The following Ten Recommendations and Associated Action Items cover a wide range of issues and possibilities for how to actively expand essential digital capacity, its many applications and its widespread use throughout all of Arizona. Our goal is to create parity and beyond in being competitive with other states and countries for this century's economic growth and well-being.

Some of the actions described are quite broad. Others are very specific. The Digital Arizona Program, led by its Council will continue to focus on those actions directly relating to facilitating the private sector's expansion of the needed physical infrastructure and its performance in concert with local, regional and tribal communities.

However, there are many other important actions defined in this plan that are not directly within the scope of the Digital Arizona mission. It is our hope that the many diverse stakeholders whose own missions are dependent on improved and expanded digital capacity will embrace those actions proposed in this plan that they can act on directly.

Great progress can be made when Arizona's individual citizens, companies, communities and governments at all levels each recognize that Arizona's standing in the world with regard to Digital Capacity is their challenge too and begin to act so that bold and positive action can be taken.

-- Michael Golden, Director, Digital Arizona Program and Broadband Planning, ASET

Recommendation #1: DIGITAL BUILDOUT

Facilitate the build-out of high-speed digital infrastructure by the private sector in cooperation with government entities (at all levels) to provide for the needs of all Arizonans.

"Reliable, affordable access to high-capacity digital infrastructure has become as essential as water, sewer, transportation and electricity service in creating healthy and successful communities in the 21st century." This is true for all communities, not just the urban and affluent ones. (Bolin, 2007)

However, rural portions of Arizona, which are unserved or poorly served by digital availability, are shut out of many improvements to education, healthcare, economic opportunities and quality of life. Some 677,662 Arizonans live in rural areas. (US Census Bureau, 2010; US Census Bureau, 2010) By comparison, the population of Arizona's second largest city - Tucson - is 510,116.

In a March 7, 2012, letter to Arizona State Legislators, Arizona Superintendent John Huppenthal stated: "The minimum speed that is educationally sufficient to support ADE's transformational plans is 6 Megabits per second per student." This speed enables uninterrupted video communication and streaming and rapid downloads of educational content whether a student is at home or at school." (Huppenthal, 2012)

The Arizona Digital map funded by a federal grant and managed through the state of Arizona's DAP www.DigitalArizona.gov shows that at these educationally sufficient speeds of 6 Mbps download, the availability percentages for households decline to 72% for rural areas, and 57% for sparsely populated rural areas. Appendix A has more detailed tables and views.

However, it is important to note that speed standards are a moving target. In a 2003 State of Arizona study high speed digital capacity was defined at speeds of over 0.2 mbps, a number that is 30 times less than the 6 mbps standard. (Tritle, 2003) The federal government has set significantly higher speed goals by 2015 and again by 2020 that dwarf today's minimum speed standards. The digital traffic flowing over the Internet is increasing exponentially. Increasingly sophisticated applications and the ever increasing use of video over the Internet for communication, education, healthcare, and entertainment is creating huge traffic demand on all digital delivery systems. The significance of this fact is that build-out of digital capacity capable of handling these increasing demands is an ongoing process and is critical to keeping rural Arizona from falling behind the rest of the state and the world.

Government policies and actions at all levels can either hinder or accelerate reducing the proportion of Americans that lack broadband connectivity. Substantial evidence shows that where government opens up its public rights-of-way (PROW) it lessens restrictions on the availability of privately owned Rights of Way (ROW), and reduces barriers that results in rapid increases of broadband connectivity.

Arizona's strategic planning focus should be on the reduction of right of way and public rights of way barriers to further deployment of broadband connectivity in order to change the private digital provider "investor equation" and to accelerate private sector investment and build-out of middle mile and last mile digital capacity to rural Arizona.

- **Implement the State of Arizona legislation codifying two highways for the price of one and support Arizona Department of Transportation (ADOT) efforts to deploy conduit including rural pilot projects on an accelerated basis**

Arizona has some 4,000 miles of highways that qualify under the Governor's new legislation to use their right-of-ways to build fiber conduit (highways in urban areas are exempted in the law). ASET through its DAP analyzed the potential for using this system. Working in conjunction with the State Land Department that has sophisticated mapping tools, some 2,000 to 3,000 rural trench miles have been identified that when built out could reach all rural Arizona communities.

The study "Essential Infrastructure for Information Delivery," served as the foundation for the passing of the Arizona Digital Highways Law. (Keeling, 2011) It is anticipated that the Law will be implemented by DAP within the ASET Office of ADOA in partnership with ADOT and private sector providers and contractors. These relationships will be essential to support ADOT's and private providers' efforts to deploy conduit on an accelerated basis.

The DAP office will leverage market forces. This plan will provide the DAP office the authority to receive and distribute funding in support of digital infrastructure projects. It creates voluntary permitting processes for digital capacity as best practices for jurisdictions that elect to adopt them, including rural Arizona government jurisdictions that do not have large legal and technical staffs to research and create such standards.

It is anticipated that the DAP will have the authority to price and manage leases to providers for access to Digital Highway conduits. This program is not intended to be a regulator but will coordinate with ADOT and digital providers in determining when and where optimum conduit construction should occur and how the funding will be provided. The program will also provide long range digital infrastructure strategic planning.

Seed capital is being sought to start development, and the generation of new revenue from leased conduit will then pay for building additional capacity. Providers may potentially invest in upfront development. The DAP will also seek additional federal and foundation funding.

Citizen benefits are driven by affordable services resulting from the DAP's barrier‐reducing and market making collaborations with providers, ADOT and others.

The Digital Arizona Council recommends that the Digital Arizona Program have the following authority and goals:

Enable through administrative action by the State of Arizona the establishment of guidelines and best practices via the DAP for digital infrastructure including permitting, ROW, and sharing including:

- A voluntary municipal application process
- E-permits
- A permitting timeline for standard types of permits
- Metrics to measure efficiency of the permitting process and compliance to issued permits
- Guidelines for the use of blanket permits for large, long-term infrastructure placements
- Best practice guidelines on the placement of above ground facilities to speed deployment
- Rationalize best practice standards for conduit construction to assist ADOT in digital highway conduit buildout, incorporating industry standards and providing relief in soil depth requirements, the use of previously disturbed portions of rights-of-way, and other cost effective construction techniques in trenching fiber.
- Guidelines for placing standard spare conduit in the Rights-of-Way at times of construction

Further, Digital Arizona Council recommends that the DAP:

- Disseminate and advocate broad adoption of uniform permitting standards among communities and other stakeholders.
- Support and advocate private and Non-Governmental Organization (NGO) adoption.
- Establish straightforward and voluntary PROW/ROW dispute resolution methods.
- Standardize processes and time-periods for obtaining PROW/ROW permits from state entities and local governments associated with constructing digital infrastructure in Arizona.
- Work to limit ROW/PROW fees to their cost basis.

• **Encourage and support public/private partnerships to upgrade and provision Arizona's digital infrastructure in the most cost-effective manner**

The most effective use of private/public partnerships to expand digital capacity is for government to share its resources more effectively with private digital providers. (Malik, 2012) If the government belongs "to the people" then this resource should be utilized to help expand digital capacity to the people of Arizona.

One example of a public/private partnership is the recently passed legislation SB 1402 cited above that allows private companies to have conduit along state highways right-of-way corridors to reduce the cost and time to market for digital infrastructure. Companies pay the state "at cost" the amount of money to gain access to this right-of-way. (Arizona State Legislature, 2012) (Arizona State Senate, 2012)

Another significant example of public/private partnerships is the sharing of tower space for equipment or co-location. This is discussed in more detail in Recommendation 9.

• **Support antenna and equipment placement on public-owned or controlled properties**

Another important public/private partnership digital buildout concept, in addition to tower locations, is utilizing government assets to place digital antenna and other equipment on the roofs and even sides of government buildings, on poles, and other creative locations that are physical assets owned or controlled by state or local governments. Many buildings and other structures that offer ideal locations for such equipment are owned by government. (FCC, 2010, p. 131)

Local and state government should make their buildings available for antenna and equipment placement at little or no cost. Just as tower co-location reduces cost, so does access to building locations. Conduit and/or fiber also travel over utility poles and in other places. Making access to these structures is important, too. (FCC, 2010, p. 131)

The National Broadband Plan states:

"Federal, state and local governments should do two things to reduce the costs incurred by private industry when using public infrastructure. First, government should take steps to improve utilization of existing infrastructure to ensure that network providers have easier access to poles, conduits, ducts and rights-of-way.

Second, the federal government should foster further infrastructure deployment by facilitating the placement of communications infrastructure on federally managed property and enacting "dig once" legislation. These two actions can improve the business case for deploying and upgrading

broadband network infrastructure and facilitate competitive entry." (FCC, 2010, p. 131)

Just as wireless networks use publicly owned spectrum, wireless and wired networks rely on cables and conduits attached to public roads, bridges, poles and tunnels. Securing rights to this infrastructure is often a difficult and time-consuming process that discourages private investment. Because of permitting and zoning rules, government often has a significant role in network construction. Government also regulates how broadband providers can use existing private infrastructure like utility poles and conduits.

- **Assess and pursue anchor tenancy opportunities for government entities in the digital planning process to facilitate demand aggregation**

An additional public/private partnership opportunity is for government to serve as an "anchor tenant" and partner with private sector entities to create enough aggregated demand in rural areas to justify digital providers investing in their locale.

"Anchor tenant" is a term to describe a large digital Internet customer. (Swire, 2009) In rural Arizona the largest digital customers are often government entities. This includes state agency offices in rural Arizona, county and city government, law enforcement agencies, K12 schools, community colleges, libraries, community centers, hospitals and other major institutions.

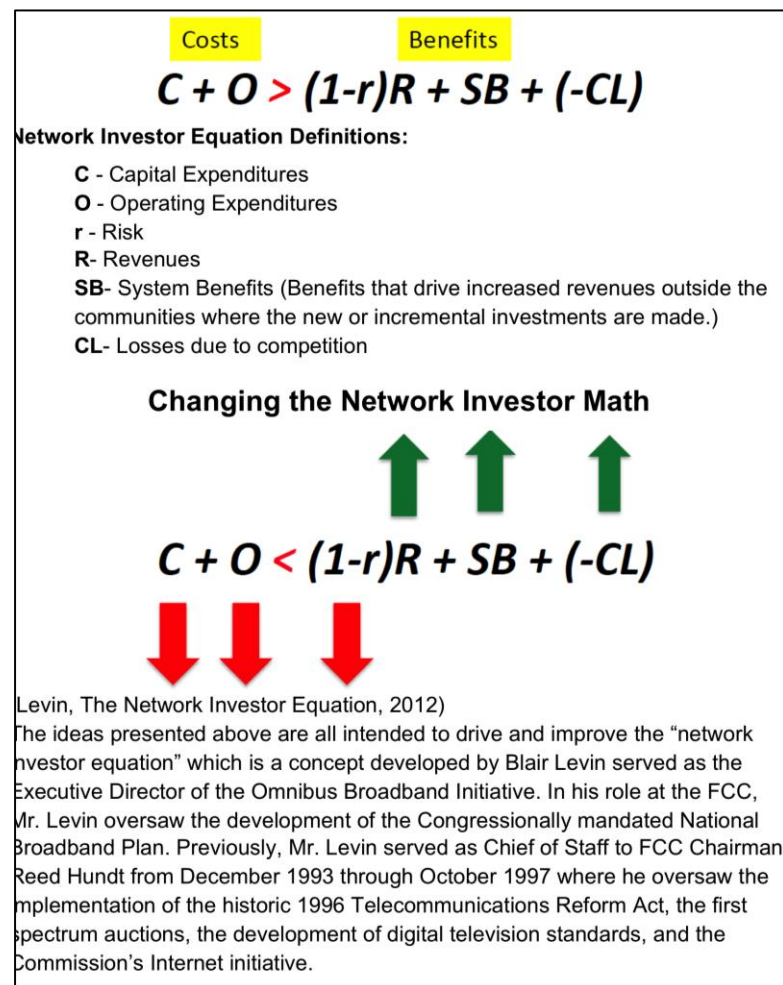## Figure 1: Digital Arizona Tactical Model Illustration
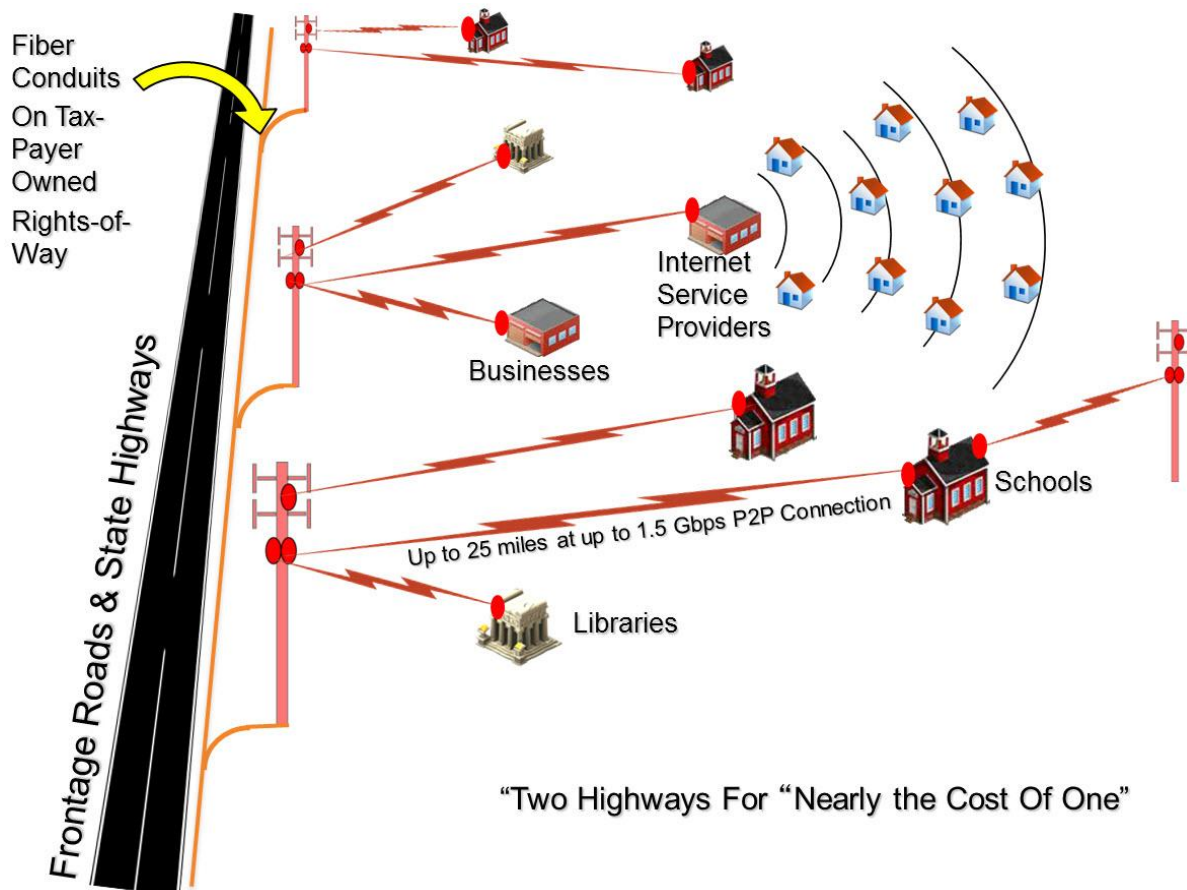
(ASET, 2011)

Together these anchor tenants provide the consistent monthly cash flow funding needed to enable a digital provider serve the greater local rural community, including small businesses and individuals. Without such anchor tenant financial support there is no business model to sustain digital service to rural residents and small businesses. It is essential that rural anchor institutions embrace digital capacity and support local area providers by serving as a customer. Anchor tenants are part of the digital planning process. (Broadband in Rural Areas, 2012) (Levin, The Network Investor Equation, 2012)

Figure 2: The Network Investor Equation

Costs   Benefits

$$C + O > (1-r)R + SB + (-CL)$$

Network Investor Equation Definitions:

C - Capital Expenditures
O - Operating Expenditures
r - Risk
R - Revenues
SB - System Benefits (Benefits that drive increased revenues outside the communities where the new or incremental investments are made.)
CL - Losses due to competition

Changing the Network Investor Math

$$C + O < (1-r)R + SB + (-CL)$$

(Levin, The Network Investor Equation, 2012)
The ideas presented above are all intended to drive and improve the "network investor equation" which is a concept developed by Blair Levin served as the Executive Director of the Omnibus Broadband Initiative. In his role at the FCC, Mr. Levin oversaw the development of the Congressionally mandated National Broadband Plan. Previously, Mr. Levin served as Chief of Staff to FCC Chairman Reed Hundt from December 1993 through October 1997 where he oversaw the implementation of the historic 1996 Telecommunications Reform Act, the first spectrum auctions, the development of digital television standards, and the Commission's Internet initiative.
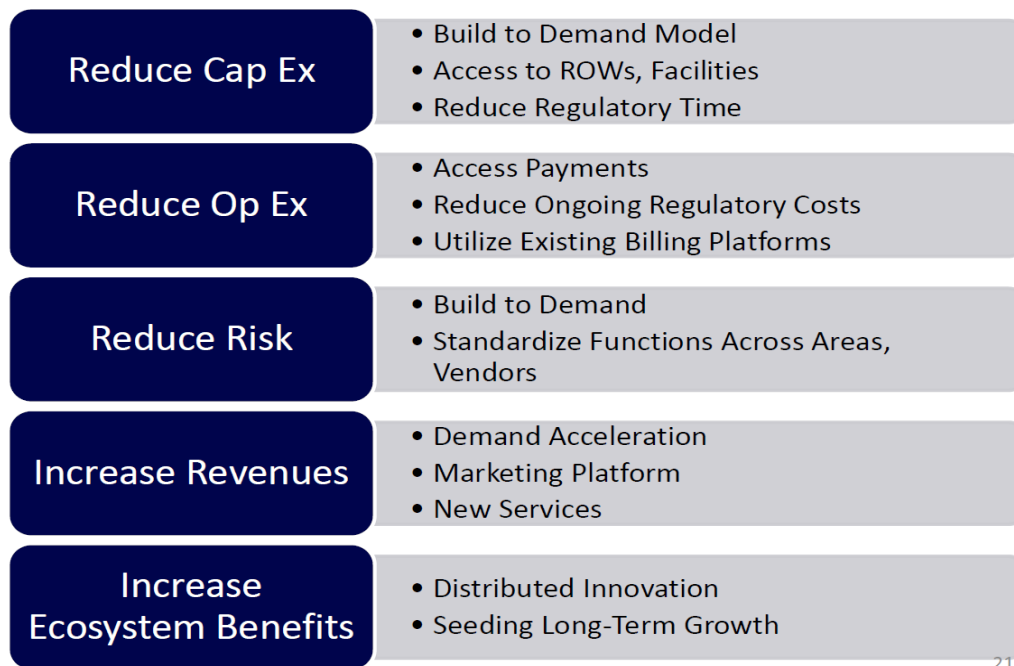
Mr. Levin's formula presented at left is intended to show how digital providers and policy makers can influence the factors involved in creating a positive return on investment in areas where providing digital connectivity can be challenging such as in rural Arizona. The DAP has current federal funding in its grant to coordinate demand aggregation in areas of need and is organizing Arizona's COGs and other rural entities to create demand aggregation opportunities.

Influencing each of the factors in the formula as shown above, reduces right-of-way costs and time to market impacting a reduction in capital expenditures (Cap Ex). Co-location of towers reduces capital expenditure requirements for digital providers. Aggregating demand through anchor tenants as digital customers increases digital provider revenues. Further recommendations below positively impact this formula for digital providers.

An implementation and funding model is shown below as an example manner in which the State of Arizona could implement the Digital Arizona Highways Act of 2012 (also known as 2012 SB 1402). This model incorporates federal recurring funds from the Universal Service Administrative Company's (USAC) Schools and Libraries Division (SLD). The USAC/SLD funds are annual recurring grant funds available to Arizona K12 schools and libraries. This is just one of many possible sources of funds.

Figure 3: How Community Efforts Can Change the Math

Reduce Cap Ex	• Build to Demand Model • Access to ROWs, Facilities • Reduce Regulatory Time
Reduce Op Ex	• Access Payments • Reduce Ongoing Regulatory Costs • Utilize Existing Billing Platforms
Reduce Risk	• Build to Demand • Standardize Functions Across Areas, Vendors
Increase Revenues	• Demand Acceleration • Marketing Platform • New Services
Increase Ecosystem Benefits	• Distributed Innovation • Seeding Long-Term Growth

Source: Blair Levin, Executive Director, Gig.U & former Director of the FCC National Broadband Plan (Levin, How Community Efforts Can Change the Math, 2012)

These funds and other funds, if organized in a fashion as shown in the model, can provide recurring revenue to rural Arizona broadband providers. In-turn these providers could utilize a portion of the funds for procuring fiber conduits and/or towers along Arizona roadways leading to the rural K12 schools, libraries and other broadband users. In return, the providers obtain long-term leases of the conduit and towers of interest to each of them.

The providers are free to utilize the leases in any manner that is commercially viable. Such utilization includes subleasing or otherwise negotiating the leases with other providers. In this fashion, the financing of conduits and towers is more likely to restructured-over-time for enabling connectivity in rural areas by multiple providers. Typically, some providers will sell broadband services directly to users while others will concentrate on wholesale services to the retail providers. It is this combination of providers jointly using the conduits and towers, having flexibility for financial restructuring over the lease term, which should allow market forces to drive the expansion of retail and wholesale digital capacity throughout rural Arizona over time.

Additionally, within the above public-private partnership constructs, ASET is exploring financing means including securitizing the leases, tax-advantaged bonding, and closer planning and funding efforts with user educational, medical-services and economic-development stakeholders.

As shown, oversight of business and funding issues associated with broadband conduits and towers in State roadway rights-of-way is provided by ASET. ASET provides an initial forum for providers and other interested parties to explore potential routing and leasing options, and negotiate the provider leases. ASET is also envisioned to contractually provide any necessary fiduciary instruments that are necessary for assuring providers that their funds will only be used for agreed to purposes.

Figure 4: Possible Digital Arizona Program Funding Model Example
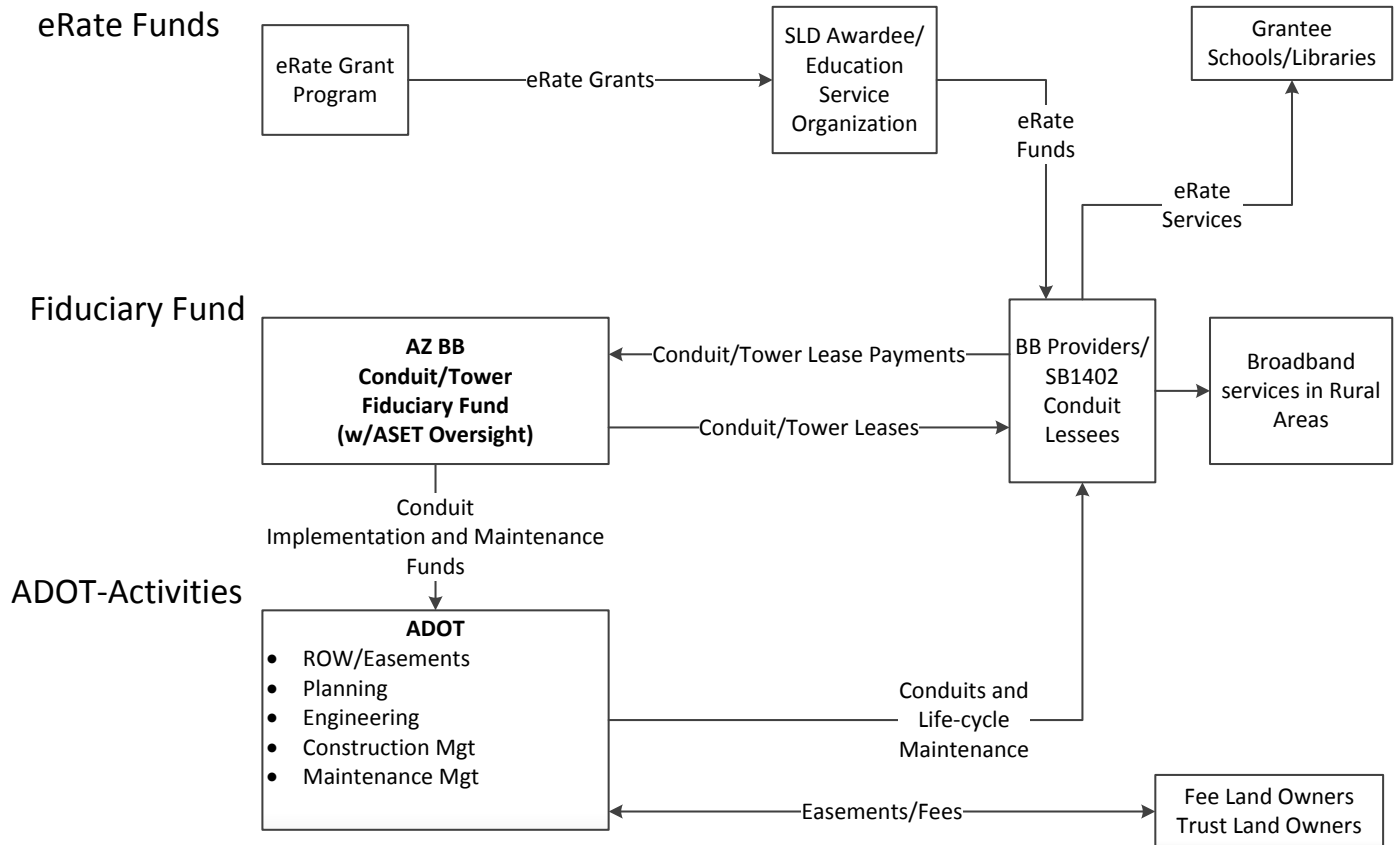
Also, as shown, the ADOT provides oversight of actual construction, maintenance, and construction safety management of the broadband conduits and towers—as well as associated life-cycle maintenance. It is envisioned that many of ADOT's current roadway planning, engineering and related standards and procedures will be utilized. Leveraging these existing standards and procedures will allow conduit and tower projects to proceed-to-completion much more quickly and safely.

Similarly, because the Digital Arizona Highways Act of 2012 expands the definition of "transportation" (as it relates to ADOT) to include the "transport of information" as well as vehicles, it is envisioned that many existing environmental and archeological studies can be can be re-utilized. In addition, ADOT currently interfaces efficiently with underlying fee-land-owners and trust-land trustees as required for establishing or expanding easements associated with the broadband conduits and towers.

Per the Digital Arizona Highways Act of 2012 all State rights-of-way and associated State-provided services are made available at cost. These costs, including administrative costs, make up the lease-rate for the conduits and tower sites that are paid by the broadband providers. Ownership of the conduits and tower sites resides with the State.

- **Drive digital infrastructure deployment to become more robust, redundant, and resilient over time to expand capacity for advanced applications and minimize the potential for interrupted service across the State**

A prioritization matrix has been developed to support the evaluation and prioritization of DAP

demonstrations and the subsequent statewide buildout staging process. This prioritization matrix will be an ongoing useful tool to determine the proper sequencing and staging of digital highway conduit buildout. This sophisticated decision matrix assists the decision making process by focusing on road segments rather than individual communities as the basis for evaluation on both empirical (data driven) and subjective levels. The tool supports a Management By Objective (MBO) framework oriented around three high level Objectives:

- Highway segment socioeconomic impact (high level physical impact)
- Highway segment ROI (prioritization by financial viability and return to providers)
- Highway segment interconnectability (Ease of interconnecting to Tier 1 Internet Capacity & SONET Ring viability and redundancy)

Within the high level objectives, nine key priorities are identified to assist the gathering of vital information within over 45 key data initiatives. The resulting informative picture will assist in determining a "staged" buildout approach. Below is an illustration that provides further insights into this prioritization matrix process:

Figure 5: DAP Buildout Prioritization Matrix
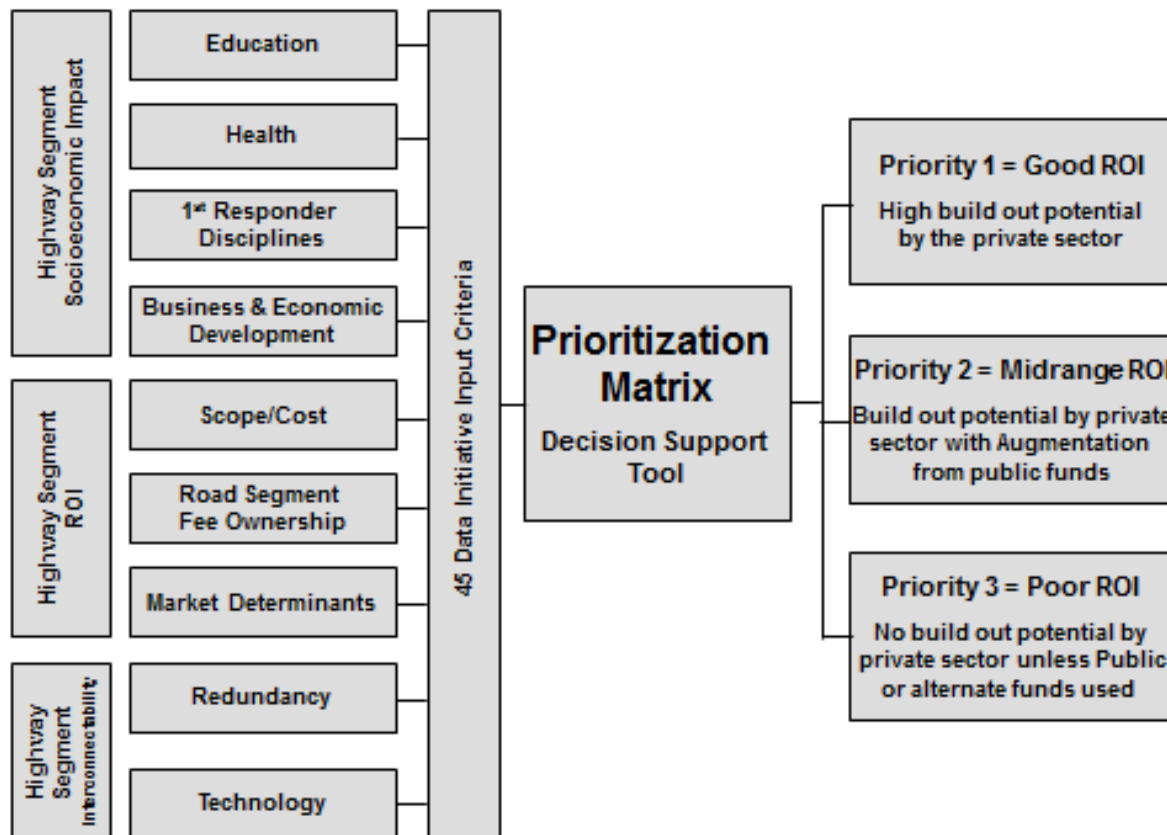
- **Provide access to state rights-of-way on a cost-recovery basis for fiber middle mile and wireless providers in unserved and rural areas**

A key DAP activity is to work with ADOT and private providers in managing conduit leasing and related issues. This work is done on a cost-recovery basis only so that capital costs to digital providers are kept as low as possible through the "two highways for (nearly) the price of one" concept. The DAP will also work to facilitate providers who seek the utilization of other rights-of-way such as utility towers, canals, railroads, etc.

By law, funding requirements for highway conduit construction must come from sources other than existing ADOT funding or the State's general fund. ADOT manages all engineering and physical construction and traffic safety issues around construction.

The Digital Arizona Highways legislation – SB 1402 - allows rural Arizona highways to be used to connect Arizona's cities and towns and become telecommunications corridors, not merely vehicular traffic highways; all without use of State General Funds or local funds. This cost-recovery provision can be made a requirement as part of an administrative action for the DAP.

The ADOT Director is enabled to construct trenches with multiple fiber conduits and cell tower sites along rural ADOT managed highways rights-of-way. Conduits will be made available to qualified carrier-class providers on a cost-recovery lease basis. Lease pricing is to be non-discriminatory. (Arizona State Legislature, 2012)

The 5-year cost estimates of this program are:

- $25,000 to $75,000 on average per rural conduit for each trench mile (depending on terraine)
- Approximately 2,500 to 3,000 rural trench miles
- $15 million to $20 million per year cost
- Covers entire state in 7 to 10 years
- Then program "sunsets" to maintenance mode only

Conduit Capacity Capabilities Impact:

This concept provides for up to 43 million Gigabits per second (Gbps) of incrementally implemented digital fiber-optic traffic along any single highway. This capacity can be distributed to communities by up to 21 million potential 1.5 Gbps point-to-point radio beams from dishes installed on cell towers supported by the highway fiber. With multiple dishes each cell tower could support - ten 1.5 Gbps Beams (15 Gbps) to each rural community. This potential capacity will support at least 100 years of incrementally and exponentially increasing demand for that capacity in rural communities and can support services that are equivalent to those available in metropolitan areas.

Every 15 Gbps of capacity beamed to a rural community represents the equivalent of:
- One Hundred and Fifty - 100 megabit simultaneous Internet connections
- Six Hundred - 25 megabit simultaneous Internet connections
- 1,800 simultaneous high-definition TV streams
- 5,400 Internet Hi Definition Internet Protocol Television (IPTV) subscribers

- **Develop and advocate for new Rights-of-way/permitting standards and procedures to facilitate faster deployment of digital services.**

Digital service providers claim that non-uniform, inconsistent permitting and rights-of-way reuse policies at all levels of government are the major source of delays and economic disincentives to building more capacity, especially in poorly served rural areas. Many State and Federal agencies that control land and right-of-way do not yet appear to be committed to the national agenda for accelerating broadband capacity by expediting and simplifying their processes and working in a coordinated and uniform way with each other. (FCC, 2010, pp. 172-173)

Creating ROW and permitting best practice standards for consideration by local rural government entities is difficult because of limited budgets, and also because of smaller legal and technical staffs than are available in larger jurisdictions. A confusing patchwork of different regulations and requirements by jurisdictions in close proximity to each other frustrates digital providers and increases their costs for legal compliance and reduces their chances of starting digital buildout projects in rural Arizona. (Keeling, 2011)

Many state and local governments have taken steps to encourage and facilitate fiber conduit deployment as part of public works projects like road construction. Similarly, in November 2009, the FCC established timelines for states and localities to process permit requests to build and locate wireless equipment on towers. In addition, a federal executive order was issued on June 14, 2012 entitled "Accelerating Broadband Infrastructure Deployment," which will significantly change the cost, speed and access to federal highways, lands and buildings for the buildout of digital infrastructure. (Office of the White House, 2012)

A November 2011 study conducted for the ASET Office and entitled "Essential Infrastructure for Information Delivery" makes six recommendations, including requiring a fixed time period for application decisions by government entities, and limiting the amount charged for fees. (Keeling, 2011)

- **Develop and pursue funding sources and mechanisms such as grants, digital bonds, public-private partnerships, and tax incentives to aid infrastructure deployment**

Creating tax incentives to build infrastructure brings down the cost of buildout and can mean the difference between yes or no to a digital provider, in determining to pursue a rural buildout project. The Arizona State Legislature recently created such tax incentives for other technology companies and this concept could be expanded to current Arizona digital providers. (Citation pending)

State tax credits for rural digital buildout for providers are another way to stimulate infrastructure buildout. Other states have used similar incentives. The cost to build rural digital infrastructure is significant because of the lack of population density. The cost to rural consumers is often higher and reduces demand. Rural schools in Arizona often pay three times more for broadband than similar service in urban schools because of distance charges. (Citation pending)

An important grant opportunity which may help Arizona advance its digital buildout is to leverage Arizona's portion of the $7 billion in funds allocated for the build out a National Public Safety Broadband Network (NPSBN) to be overseen by the First Responder Network Authority (FirstNet) working in conjunction with the States.

A solution to our Public Safety communications interoperability challenges has been a national goal

since the tragedies of September 11, 2001. The NPSBN will go a long way toward solving many of the issues. . FirstNet's NPSBN is intended to allow first responders from different agencies, departments and jurisdictions to effectively communicate with each other in an emergency.

The allocated $7 billion will go a lot further toward fulfilling our coverage needs if the types of cooperative sharing arrangements that DAP has been proposing are considered and implemented. (Strickling, 2012) For instance, to obtain optimal 4G LTE coverage, more tower sites will be required in each local jurisdiction. If those site requirements could leverage local governmental buildings and structures, and if Public Safety would allow sharing of the existing LMR tower sites for wireless use by all users then a mutual benefit could be realized.

Arizona's portion of the FirstNet funds could also be leveraged through the SB 1402 initiative allowing FirstNet and other digital providers to use the same trench, with separate conduits for each purpose and provider.

The initial phase of the FirstNet grant process will begin with $135M in funds set aside for State and Local Implementation Planning (SLIGP). Details of the SLIGP grant guidance are not currently available, however, Arizona will be ready when they are available through the efforts of the PSIC Office, the Public Safety Communications Advisory Commission (PSCC) and the ASET office.

There are also several federal American Recovery and Reinvestment Act (ARRA) digital grants that were awarded to entities in the State of Arizona under the ARRA funding that expand digital capacity in rural areas and on tribal nations. Most of the money impacting Arizona is for infrastructure grants and many of these grant projects are currently under construction. The DAP maintains a list of these grants on the website. **(DAP, 2012) (PSIC, 2012)**

The federal government also funds significant digital infrastructure development through a nominal fee on monthly telephone bills. This fund is called the Universal Service Fund (USF). This fund is managed for the FCC by an independent organization called the Universal Service. There are four major program areas funded by this fund, including the eRate program to fund broadband and telephone connectivity as well as technology and equipment for schools and libraries. The "e" in eRate stands for "education" but the program is most commonly referred to as eRate. (USAC, 2012)

eRate funding pays for some of the cost of Internet and telephone service to schools and libraries. The reimbursement rate is based on economic need and determined by a federal formula involving the school lunch program. Schools with the greatest need have 90% of their costs reimbursed.

The application process to apply for eRate is complicated. Many schools are denied funding because of application mistakes. Most schools that successfully apply for eRate utilize professional eRate consultants to assist them because of the complicated nature of the process. However, many schools in great need cannot afford an eRate consultant to help them, and have a much higher rejection rate from USAC as a result. (New York Times, 2000)

Other barriers include the lack of funding on the part of schools for the needed "match" to the federal dollars. (New York Times, 2000) This required match can be 10%, 20%, or more. For a "90% school," $10,000 buys $100,000 in broadband services or computer related equipment, with $90,000 in funding coming from the USF administered by USAC. The required match can be from the school, or any other source such as a private individual, foundation, or special state agency fund. (E-Rate Program Office, 2012)

Because of these profound challenges to Arizona schools and libraries in applying for eRate the

state legislature saw fit to create an eRate fund within ADOA's ASET Office, where the broadband expertise of the state resides. (E-Rate Program Office, 2012). The currently unfunded state's eRate fund is allowed to accept tax-deductible contributions from corporations, corporate foundations and individuals. (E-Rate Program Office, 2012)

This Arizona eRate fund is authorized to provide matching funds for schools in need, and to fund professional eRate consultants to schools that cannot afford them on their own. The fund conducts research on eRate to help identify the schools most in need that are not applying for eRate because of the challenges they face. (E-Rate Program Office, 2012)

In 1989, the Arizona Corporation Commission (ACC) adopted rules in Decision No. 56639 establishing the Arizona Universal Service Fund (AUSF). Those rules are contained in Title 14, Chapter 2, Article 12 of the Arizona Administrative Code. The AUSF is currently designed to ensure that customers living in high cost areas of the state receive basic telephone service at reasonable and affordable rates. At the present time, only one carrier receives AUSF support. The ACC has a proceeding underway to consider modifications to the proposed rules to support intrastate access charge reform. However due to recent preemptive actions of the FCC the status of the AUSF rule changes addressing intrastate access charge reform is uncertain at this time. Other changes to the rules, not proposed in the current proceeding, would have to go through the rulemaking process at the Commission and be approved by the ACC.

Recommendation #2: INCREASE ADOPTION

Increase the use and adoption of high capacity digital connectivity and technologies

There are other barriers to digital Internet access and usage, in addition to the lack of digital infrastructure in rural Arizona.

Not every individual knows how to use the Internet. Some are apprehensive about trying it. Others have no access to learning how to use the Internet effectively; or are unaware of such opportunities in their community. (FCC, 2010, pp. 167-168)

The State of Washington brought together a group of technology experts and defined digital literacy as having the "skills required in order to utilize the equipment and Internet effectively for essential services, education, employment, civic engagement and cultural participation." (Saunders, 2011)

Thirty-six percent of people who do not use the Internet say cost is their biggest obstacle. Among 31 developed nations the U.S. ranks seventeenth from the top nation in Internet access affordability. (FCC, 2010, pp. 167-168)

Some people live far from the nearest library or community center where Internet access is available for free. Others are homebound and do not have transportation. (FCC, 2010, pp. 167-168)

The United States invented and developed the Internet. The national average adoption rate for using broadband is 65%. This ranks 14th among 31 developed nations. (FCC, 2010, pp. 167-168) This means one-third of our nation's population does not use the Internet. In South Korea and Singapore the adoption rate is 90%. (FCC, 2010, pp. 167-168)

For people without a high school degree in America it is even worse, a 24% adoption rate. For Americans over 65 years of age it is 35%. For people with income under $20,000 a year it is 40%. For people with disabilities it is 42%. For rural Americans it is only 50%. (FCC, 2010, pp. 167-168)

Some 10 million students nationwide do not have home access to the Internet. (FCC, 2010, pp. 167-168) Classroom teachers report a stark difference in the learning abilities between students with and without home Internet. Teachers find it difficult to teach to a divided class of such learners. Studies show that home Internet use increases academic learning. (FCC, 2010, pp. 167-168)

- **Support and advocate for programs by industry and nonprofits to ensure that every household has sufficient high-speed Internet access, digital devices, and the skills to use them**

The Connect to Compete Program was announced last fall by the cable industry and FCC Chairman Julius Genachowski. This program is a partnership effort to address the issue of broadband adoption challenges through a low cost opportunity for connecting low income families to broadband and educating them about the opportunities. (FCC, 2011)

The Connect to Compete Program is expected to begin by the third quarter of this year. Under this program families with at least one child receiving free school lunches through the National School Lunch Program are eligible for the $9.95 monthly Internet and low-cost computer offerings. There are no installation or activation fees and no modem rental fees. This is an average discount of 70%

off typical monthly broadband service costs. If every eligible family took advantage of the offer it would constitute a $2.5 billion in-kind contribution. (FCC, 2011)

Arizona schools need to provide digital devices such as laptops and tablets to students in need in order to make home Internet a reality. Schools can save significant funds by switching from bound textbooks to digital ones. Some textbooks used in Arizona are several years old. Because information changes so quickly having a digital textbook is better because it can be updated anytime. (Attwell, 2006)

A $150 refurbished computer will be made available to all eligible school lunch families through a company called Recemtech as part of the Connect to Compete program. There is also a $250 computer option that will be introduced, and many software companies are offering computer training and other software. Morgan Stanley will offer credit to families who cannot afford the upfront costs of these computers. (FCC, 2011)

Studies show that home computer access increases student academic performance. The U.S. is currently ranked 18th in the world in access to digital Internet by students. (FCC, 2011)

- **Create a community technology resources database detailing community hotspots and facilities, training programs, technical support organizations, and sources for affordable digital devices**

Many people in need of access to the Internet simply are not aware of places where they can go to obtain this capability for accessing information that is vital to improving their lives. This includes information for job searches, resume writing and training programs. Such locations include places where citizens can utilize free community hotspots and public computer facilities such as libraries and computer centers, and even many fast food restaurants.

A community resource database with information on local computer and digital learning opportunities, community hotspots and affordable services is needed.

- **Promote the use of community institutions to provide technology access and training**

Libraries are key centers of influence and opportunities to utilize digital resources. Many digital tutorials are available online for free or are provided by funding through the state and local Arizona libraries. Technology access at some libraries in Arizona is not adequate. Many libraries have limited computer facilities, digital bandwidth or space. People who are unemployed often have to cancel their home Internet subscriptions, and use public facilities like libraries or community centers to do their job searches and applications. More computers in many of Arizona's libraries are required, as is greater bandwidth. (Huffington Post, 2010)

Community Colleges provide an ideal venue for teaching people technology. Community Centers are another venue, such as Senior Centers, American Legion and VFW halls, Boys and Girls Clubs, the YMCA and YWCA. Churches, synagogues and mosques can also help. All these institutions can create programs and provide computer training to their members and other people in need.

- **Support community-based institutions in expanding digital literacy programs**

The most important support community institutions need in creating or expanding digital literacy programs is identifying and recruiting qualified individuals who can teach and conduct such programs to train groups and individuals.

Many young people today know how to use computers well. In fact, some of the most knowledgeable users of computer technology today are Arizona's younger citizens. The funds to pay individuals to teach community digital literacy programs on a grand scale are simply not available from government or other sources.

However, many young people in high school are required to provide a certain number of hours of community service in order to graduate. Students at the college level, including those who belong to service clubs or fraternal or sorority organizations, are also required to do the same.

Creating a Digital Arizona Corps of high school students and some college students who need community service hours in order to graduate or maintain their membership in their school based clubs should be utilized to provide digital training to those in need. These qualified digitally literate Arizona students are essentially an army of complementary computer teaching talent waiting to be tapped to help others learn how to navigate the digital divide.

- **Develop a marketing plan and educational campaign to promote digital adoption and its fundamental importance to Arizona's future**

- **Focus on removing barriers for re-use of digital technologies to help bridge the social digital divide**

- **Address the digital divide by increasing affordability through private and public programs of direct and indirect subsidy, lowering the cost of infrastructure, and fostering enhanced competition**

- **Disseminate best practices to address privacy, safety, and Internet identity concerns.**

Figure 6: What Happens in an Internet Minute?
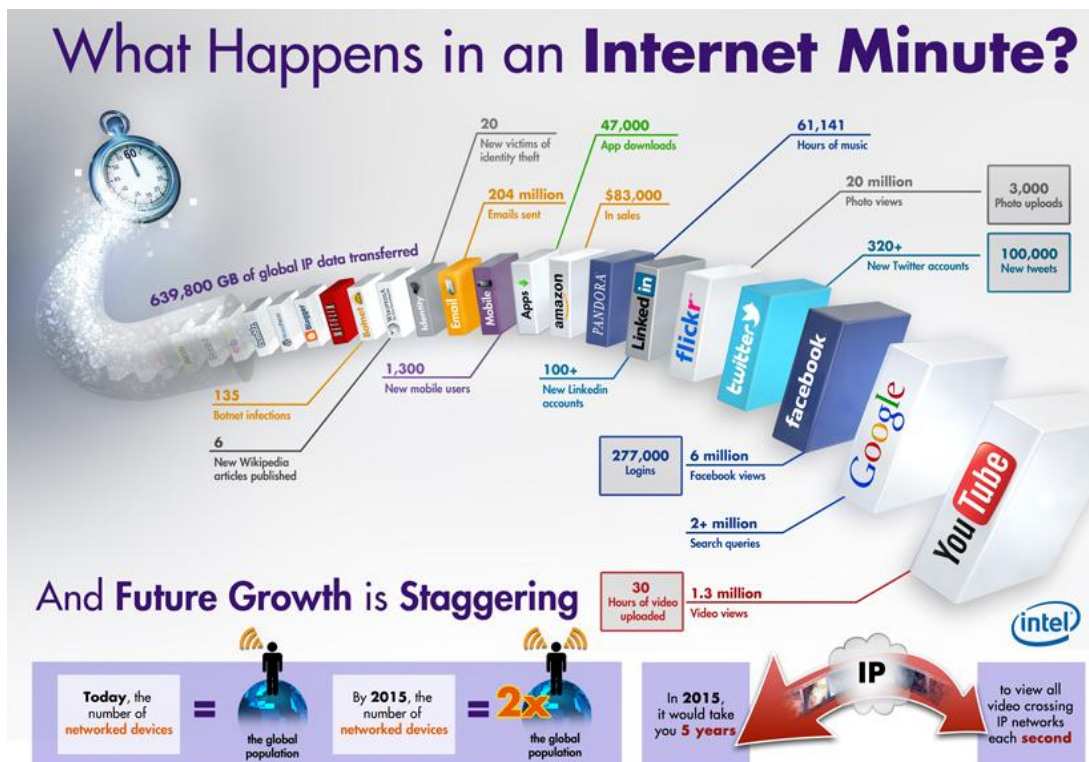
(Intel Corporation, 2012)

Mobile Data Traffic Forecast for North America in 2016

In North America, mobile data traffic will grow 17-fold from 2011 to 2016, a Compound Annual Growth Rate (CAGR) of 75%. (Cisco Corporation, 2012)

"Network infrastructure as a topic lacks the appeal of slick mobile devices, cool social and location apps, streaming music or viral videos. Yet without the fast-flow of data a robust network infrastructure supports, they all come to a grinding halt. This infographic demonstrates the enormity of the need for network capacity beyond just mobile and video uses and forecasts a future that assures that network providers will be scrambling to keep pace."

Recommendation #3: LEADERSHIP MATTERS

Formalize and sustain state-level and regional digital leadership

Federal funding runs out in 2014 for Arizona's digital capacity mapping and planning grant. However, the need for broadband in Arizona keeps growing.

The National Broadband Plan's milestone goal for digital capacity speeds in 2015 is 50 Mbps download, 20 Mbps upload. The plans goal is that by 2020 one hundred million U.S. households will have digital speeds of 100 Mbps download and 50 Mbps upload. The current definition is 4 Mbps download, and 1 Mbps upload. (FCC, 2010, p. 9)

Arizona's digital infrastructure needs to grow after 2014 to meet this requirement. The demand for digital capacity is increasing exponentially. Formal state and government leadership needs to continue to meet this demand.

- ## Continue the current ASET Broadband Office Mapping and Planning Activities past the end of federal grant funding in December 2014

This State Strategic Digital Plan needs to be a living document with ongoing evaluation and changes. A professional project manager should be utilized to oversee the implementation of these initiatives and monitor their progress.

A funding mechanism should be identified for maintaining the semi-annual broadband mapping process that provides vital data as to needs and digital deficits in Arizona; along with the planning dollars it needs to sustain state and regional digital leadership in a formal way. The state needs to continue to employ a digital team under the direction of the state CIO's office that facilitates and coordinates these activities.

Funding is also needed to maintain and update regional strategic digital planning done through the four rural regional COGs. These entities have some funding and staff; and bring together key people from throughout their rural regions for economic development and planning, advising the state on location of highways, and other important infrastructure efforts. The COGs are ideal organizations to partner with in rural regional digital planning efforts.

DAP is likely to produce some revenue to pay for digital projects, staff and activities from private sector sources. FirstNet federal grant funds may be available for some of these activities. However, the funding stipulations for this $7 billion national grant opportunity are not yet defined. There may be additional federal grant money made available by the time this federal grant runs out, although it appears that this is unlikely. The Arizona Legislature should appropriate funds to continue these efforts, if needed.

- ## Continue the Digital Arizona Council leadership role in promoting sufficient digital connectivity initiatives

The DAC should be formalized on a permanent basis, and this Council should help drive the digital connectivity initiatives of the state. The Council membership should continue to reflect the diverse areas of interest in digital capacity, and to be chaired, as it is now, by the state CIO.

Many other states have utilized a formal digital infrastructure state leadership structure with funded staff, prior to the awarding of federal ARRA grants to the states to create such entities. This formal structure helps these states to build their digital capacity, including rural areas. The states of North Carolina and Utah are two of the best examples. (Woolley, 2011)

The National Broadband Plan, which was used in part as a model for Arizona's strategic plan, noted about the national effort: "This plan is in beta, and always will be. Like the Internet itself, this plan will always be changing - adjusting to new developments in technologies in markets, reflecting new realities and evolving to realize previously unforeseen opportunities." (FCC, 2010, p. 333)

- **Promote public/private partnerships through the creation of community-based digital leadership councils to increase demand in communities with insufficient digital capacity**

The optimal way to promote public/partnerships is through community-based digital leadership councils and to work through Arizona's six existing COGs.

Four of these COGs are rural including the Northern Arizona Council of Governments (NACOG), the Central Arizona Association of Governments (CAAG), the Southeastern Arizona Governments Organization (SEAGO) and the Western Arizona Council of Governments (WACOG).

These COGs already have memberships that are ideal for advancing digital capacity initiatives in their jurisdictions. These entities have formal funding and paid staff. They are actively involved in recommending needed highway projects in their areas. With the passage of SB 1402, which allows state highway ROWs to be utilized to build digital capacity, they are a natural focal point for regional leadership in digital capacity. The COGs are diverse in their membership and include elected officials, business leaders, education and healthcare leadership and others.

The COGs' planning processes need to be coordinated with the State Strategic Plan. These efforts will be coordinated through the planning portion of ASET's federal digital grant, which should be continued after the grant funding ends in 2014. These activities are currently under the ASET DAP and should continue there.

- **Promote regional strategic plans that align with the state strategic plan**

Through these four rural COGs authentic regional strategic plans for digital capacity can be created. The COGs already have sophisticated strategic plans for other important initiatives and needs of their area. These plans can be utilized in building out the COGs' digital capacity strategic planning since digital capacity will drive almost all the other goals and initiatives in the COGs' current strategic plans - including economic development and job creation.

Initial funding for this regional strategic planning comes through the current federal digital grant under the administration of ADOA ASET. This funding is being coordinated overall by ASET but involves other organizations such as the long standing Arizona Telecommunications and Information Council (ATIC), and its newer sister organization the Arizona Telecommunications and Information Institute (ATI Institute) which is a qualified 501(c)(3).

Other jurisdictions are eligible for this funding, including rural counties and towns, and regions within the COGs that make sense based on geography, common interests or common economic factors such as tourism, mining or agriculture. These strategic efforts factor in and coordinate with recent

federal broadband grant recipients. For example, several Native American reservations received significant digital funding and many of these projects are in construction. There are synergies with nearby communities from these types of grants. (DAP, 2012)

- ## **Monitor, influence, and align federal digital capacity legislation, rules, regulations, judicial decisions, and funding programs.**

- ## **Work with the Arizona Corporation Commission to evolve the state Universal Service Fund to support digital services and related initiatives**

Under its 1989 Decision No. 56639, the ACC established an intrastate universal service fund (AUSF) to maintain statewide average rates and availability of basic telephone service – as reasonably as possible. The AUSF is funded by all telecommunications providers that interconnect with the public switched network or that provide intrastate toll service. The current AUSF monthly Access Line Assessment Rate is $0.009524 per access line; the Monthly Interconnecting Trunk Assessment Rate is $0.095241; and the Monthly Intrastate Toll Revenue Assessment Rate is 0.3225%.[1] These rates generate approximately $750,000 to $1 million per year and support in part affordable service in a portion of Frontier's service territory in Arizona.[2]

The ACC has an open docket[3] for considering possible repurposing the AUSF in part. However, given recent actions by the Federal Communications Commission ("FCC") the ACC Staff "does not believe that the current record is sufficient to support any revised recommended reforms,…." Further, Staff advised that the "Commission should hold the current docket in suspension until the jurisdictional issues are sorted out at the Tenth Circuit Court of Appeals; or until someone demonstrates a need for Commission action prior to that time."

Other proposed changes to the AUSF, not encompassed within the current proceeding now on hold at the ACC, would have to go through the rulemaking process at the ACC and be approved by the Commission.

Because the ACC is open to someone demonstrating a clear need for the ACC to act; there exists an opportunity for consigning AUSF funds for digital buildout for Arizona's schools through the Education eRate Office at ADOA with input from important stakeholders. These funds should be utilized for the State's eRate program to augment matching funding from schools. Through the federal eRate program, these additional matching funds this can bring as much as 90% additional broadband funding to Arizona. This equates to a potential $9 million in extra broadband funding for Arizona schools every year.

In order to repurpose the fund in part to specifically support broadband deployment in poorly served areas or funding for other purposes, such changes would have to be proposed to the Commission as part of a new rulemaking proceeding, and the Commission would have to approve a rulemaking

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[1] *In the Matter of the Notice of Proposed Amendments to the Arizona Universal Service Fund*, Docket No. RT-00000H-97-0137, Decision No. 72727 (January 6, 1012); See also, Procedural Order, Docket No. RT-00000H-97-0137, (January 25, 2012).

[2] *Id*. at para 3.

[3] The ACC opened a generic docket (RT-00000H-97-0137) in 1997. Recently the Commission consolidated the docket with another generic access charge docket (T-00000D-00-0672) for the purpose of determining whether or not the AUSF needs reforming.

package to go through the normal rulemaking process for adoption.

An example of collaborative efforts between a state office of information technology and the state public utilities commission to promote broadband deployment in unserved areas is SB12-129,[4] a senate bill sponsored in the Colorado legislature last session.

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[4] http://www.leg.state.co.us/clics/clics2012a/csl.nsf/fsbillcont3/7a5cc6e4177ac95f87257981007dff8e?open&file=129_01.pdf

Recommendation #4: PLANNING AND ECONOMIC DEVELOPMENT ARE CRITICAL

Drive digital-related local community planning and economic development

Digital capacity helps local economies create jobs. A 2011 McKinsey Global Institute study concludes that the Internet accounts for 21% of all Gross Domestic Product (GDP) growth over the last 5 Years in developed countries. (Pélissié du Rausas, Manyika, Hazan, Bughin, Chui, & Said, 2011) A 2007 MIT study concludes that in counties with broadband deployment the sales per capita grew almost twice as fast as counties without it. Digital deployment increased employment by over 5% with such deployments having a greater impact in smaller, rural communities. (Gillett, Lehr, Osorio, & Sirbu, 2006)

A 2011 Chalmers University study concluded that every doubling of broadband speed increased GDP by 0.3%. (Rohman, 2012) If this Chalmers University calculation is applied to rural Arizona's economy it potentially has the following impact:

> Arizona Annual GDP - $277 billion
> X 15% (rural portion of Arizona GDP)
> X 0.6% (4 x increases in rural digital capacity - 1 mbps to 4mbps.
> = **$249 million potential Arizona Rural Increase/Year from digital capacity expansion**

Another recent study reports that a 10 percent increase in broadband penetration in high income countries such as the United States would cause a 1.2 percent increase in GDP. (Johnson, 2012) Other research institutions report similar findings. (Broadband Commission for Digital Development, 2012)

- **Conduct regional and community-based market assessments and create a Digital Gap Analysis Program (GAP) leading to an economic development plan**

Gap analysis is a frequently used tool that helps identify the gaps between a current situation and a future state that is a goal, along with the tasks needed to complete and close the gap.

The COGs are ideally situated to carry out GAP analyses for a given region. A map below shows the COGs and what counties are included in each region.

The COGs are made up of elected officials, business leaders and community leaders who come together to promote their regions economically and otherwise. COGs have professional staffs and ongoing funding. They play a key role in helping to determine the buildout of state highways in their region. This is ideal since the recent passage of SB 1402 allows digital conduit to be built along Arizona's state highways.

COGs can do formal strategic planning and these plans are part of their efforts to plan digital capacity for rural Arizona. A federal grant provides funding and coordination for digital planning in Arizona. This planning is incorporated into the COGs' strategic planning.

- **Find and define digital provider market opportunities**

The local market assessment analysis serves as a fountain of data that feeds planning. The Arizona Digital Mapping process provides important data in this planning process. There are other existing databases and reference sources such as REF USA that are part of the planning and marketing process.

There are two flavors of market opportunities for digital providers to build in rural Arizona. One is that increased digital capacity can improve a local economy by providing a resource that attracts new market opportunities. The second is because service providers historically have enjoyed better economy in densely-populated areas, rural communities and regions should develop local digital-capacity markets and make them attractive to service providers.

- **Model and measure economic impacts against proposed digital capacity policy initiatives**

Employ community resources to conduct the measurements. Use subject-matter experts to develop the measurement models. The primary goals are job creation and job retention. These are measured in order to determine return on investment, and create leverage for sustained and future development funding. A secondary, or resulting, measurable goal is to sustain or increase the community's tax revenues while maintaining or reducing the distinct tax burdens. The tertiary measurable goal is to decrease opportunity costs.

Figure 7: The Internet Drives Job Creation
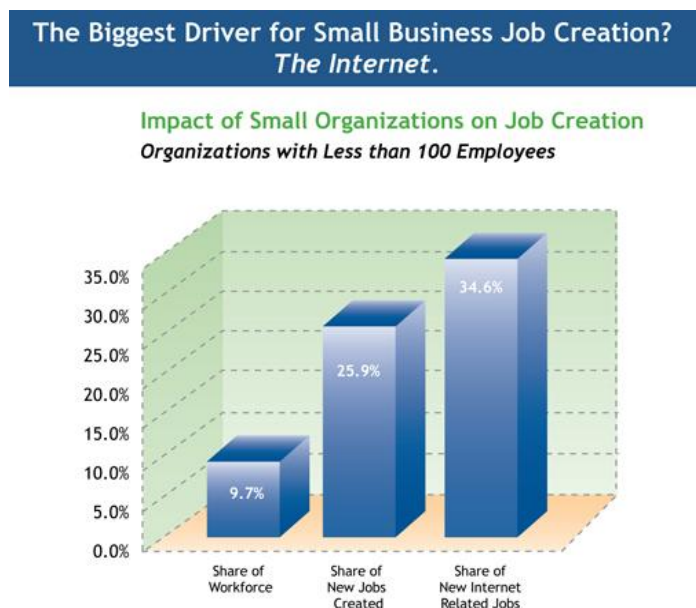
(Strategic Networks Group, 2012)

Figure 8: The Internet's Impact on Jobs
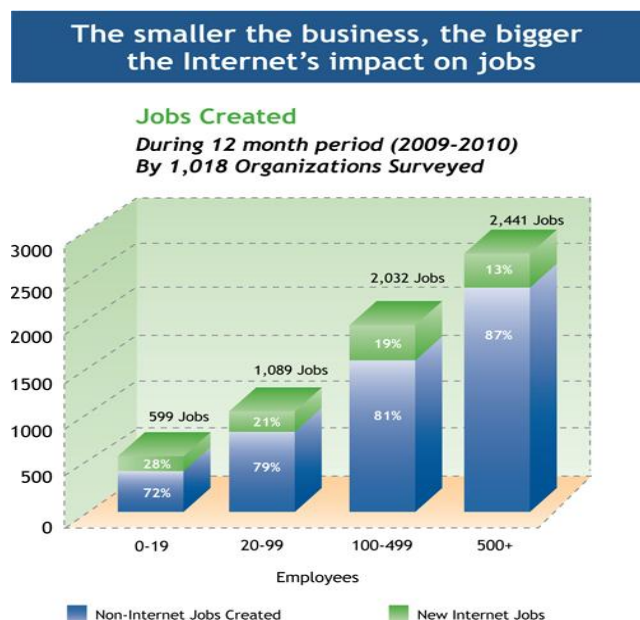
(Strategic Networks Group, 2012)

Recommendation #5: OUTREACH

Drive community outreach through policies, programs and local engagement

Community outreach provides information, coordination, education and access to supportive resources that stimulates and guides the development and implementation of local and statewide digital initiatives. An outreach and awareness campaign covering all of Arizona needs to be developed. It should showcase the usefulness and benefits of broadband and online resources across all segments of society.

- **Provide resources and informational seminars on digital capacity to communities and regional organizations**

- **Provide collaboration opportunities related to digital concerns to communities and regional organizations**

There is a need for collaborative two-way flows of information between rural areas and statewide planning and coordinating organizations. Examples of such statewide entities include ASET, ATIC, ATI Institute, the Arizona Association for Economic Development (AAED), the Arizona Technology Council and the ACA.

The DAP and ATIC should provide and coordinate periodic statewide digital capacity roundtables for all stakeholders with audio, web and video conferencing available. These roundtables include one or two featured presentations at each meeting, updates and information sharing, project and vendor showcases and informal networking opportunities

- **Provide to communities digital last-mile infrastructure planning templates and checklists**

- **Provide digital technical consulting to communities for analyses, planning, proposals, and implementation**

- **Provide assistance to community and regional organizations in writing digital grant applications**

Recommendation #6: EDUCATION AND JOB READINESS

Facilitate the implementation of underlying technologies, digital curricula, collaboration and professional development to promote improvements in education and workforce development

- **Encourage the connection of universities, colleges, schools, libraries and students' homes with sufficient digital capacity to enable advanced e-learning applications and serve the needs of the rapidly evolving statewide data based decision support system.**

"A tidal wave is about to hit us."

**Gordon Wishon
Chief Information Officer
Arizona State University**

Commenting on the rapid changes taking place in education technology today.

Some of the most advanced applications of K12 education technology taking place anywhere are in Arizona schools. Imagine high school students taking a math probability lesson from a --Harvard math professor, live, 2,600 miles away, or students in Eloy, Arizona, learning French from the National Online Teacher of the Year, teaching from Arkansas. (deLuzuriaga, 2010)

A list of exemplar Arizona schools in education technology and a summary of their efforts is in Appendix B of the Expanded & Reference version.

In America, 45,000 K12 students took online classes in 2000. By 2009, the number was more than 3 million students. (Nagel, 2009) Professor Clayton Christensen of Harvard's Business School predicts in his book "Disrupting Class" that by 2019 half of all high school classes will be online. (Christensen C. M., 2008)

In Florida, students attending Florida Virtual Schools (FLVS) average higher AP and state standardized assessment scores. Students that have a computer and digital access in the home have a 6% to 8% higher graduation rate than those who do not. (FCC, 2012) 20% of Arizona's students do not have access to home Internet. Arizona's graduation rate in 2009 is 72.5%. The national average in 2009 is 75.5%. (Balfanz, Bridgeland, Bruce, & Fox, 2012)

In a March 7, 2012, letter to Arizona State Legislators, Arizona Superintendent John Huppenthal stated: "The minimum speed that is educationally sufficient to support ADE's transformational plans is 6 Megabits per second per student. This speed enables uninterrupted video streaming and rapid downloads of education content whether a student is at home or at school." (Huppenthal, 2012)

The National Broadband Plan, (FCC, 2010) makes it a long-term goal to provide 1 Gbps per second of digital service to schools. There are schools in Arizona that have only 3 Mbps of digital capacity, a tiny fraction of the capacity that 1 Gbps provides. There are many schools and homes in Arizona that cannot meet these standards.

Arizona's Education reform plan prepared by the P20 Council appointed by Governor Brewer. notes the importance of "high quality data systems to inform instruction, drive innovation and

improve accountability." (P20 Council, 2010) Having adequate bandwidth to all of Arizona's schools is a foundation for these data systems to be utilized. (Huppenthal, 2012)

One of the great benefits that technology can provide education for teachers and students is a measurable history that can be utilized to track students' progress, catch learning gaps and problems early and fix them, and improve overall results. (Deschel, 2012) The State is creating such systems today. (Masterson, 2012)

Testing can put an enormous load on IT systems and digital capacity when tens of thousands of online classes are growing dramatically. Adequate bandwidth will be necessary to make these systems work. (Masterson, 2012)

ADE's IT department is currently operating and developing three data based decision support services for P-20 + Workforce with longitudinal databases. The Student Accountability Information System (SAIS) and Student Longitudinal Data Base (SLDB) with dashboard are two systems that are finally in operation after 15 years of development. ADE IT developments are refocusing from the state level governance decision support to decision support of real-time learning in schools. (Masterson, 2012)

The new Partnership for Assessment of Readiness of College and Careers (PARCC) assessment testing is required to be taken online. With numerous students taking this test simultaneously, many schools simply do not have the digital capacity and infrastructure to conduct this test at their schools.

Arizona currently does not have a statewide high capacity digital network. (Manfield, 2011) Utah created a statewide education network that reaches Utah's schools with significant bandwidth and offers many online eLearning classes. Many other states have statewide education networks. (Utah Education Network, 2012) To make a statewide education network successful students need adequate digital capacity at school and at home.
The walls between universities, colleges, schools, libraries and students' homes are coming down. Some Arizona high school students are graduating today with their high school diploma and simultaneously their community college degree, paid for by their K12 school. School districts throughout Arizona are now actively signing Intergovernmental Agreements (IGAs) and sharing resources. (Northern Pioneer College, 2012) Even Harvard, MIT and Stanford now offer hundreds of non-credit classes taught by their professors online available for free to anyone with enough digital connectivity.

- **Evaluate the bandwidth, technology, and support needs of educational stakeholders to create an adequate, effective and accessible learning support system**

Many K12 school districts' IT departments are overwhelmed with the daily activity of running and managing their systems and have little time to evaluate their bandwidth, technology and support needs. This at a time when the opportunities through education technology are changing and improving dramatically.

Some school districts in Arizona are so small that the IT staff is a teacher who knows the most about computers. Arizona has over 225 public school districts and over 500 charter schools. There is a need to develop an understanding of emerging technology eLearning solutions from major vendors, venture capitalists and other experts to garner a prediction of growth of per-student digital capacity needs over what is represented by exemplar schools.

Then compare this bottom up forecast with the top-down driven exceptions presented by ADE,

FCC, and others and get quantitative results.

- ## Consider State and national network expansion initiatives for students, workforce and faculty living in limited-access communities.

As mentioned above, the 2010 census shows 677,662 people in rural Arizona. Arizona is unique in its vast Native American Reservations and rural topography. (Rural Assistance Center, 2012) Many students, workforce and teachers living in limited-access communities can benefit from state and national network initiatives. The Digital Arizona Highways Act of 2012 allows the ADOT to lay multi-cable conduit beside Arizona highways and for providers to use this conduit. This removes a significant cost barrier to vendors increasing their incentive to build fiber-optic cables into rural and isolated communities. Once in reach of a community, a microwave tower can connect to the fiber and beam the final miles to schools and other telecommunication hubs for last mile hookups.

By the end of 2012 it is expected that prototype rural communities are selected and digital extensions underway. A critical aspect is the commitment of the community to rapidly adapt and use this utility for education and training, healthcare, economic development and citizens.

There is an effort in Arizona to create network IT standards for a statewide education network called SEDNet (SACCNet Education Network). (SEDNET, 2012) Networks succeed if the key parties have enough digital bandwidth, collaborate, and utilize it. Arizona's students would benefit tremendously and have many new opportunities if Arizona had a statewide education network with sufficient digital capacity to connect all of the state's K12 schools, community colleges and universities.

A national network called the National LambdaRail (NLR) is a super high speed intranet system that is used by the top universities and research institutions in the world. Recently, K12 schools have started to use this network, and a similar network called Internet2, to conduct classes and guest lectures with some of the top minds from Harvard, Duke and universities in Europe, Asia and Australia.

The first K-12 in the world to get on the NLR is in Arizona. Only an existing member can allow another institution to gain access to this 12,000 mile fiber system which goes through Arizona and has a super computer center located in Phoenix. ASU and the University of Arizona are members of the NLR.

- ## Provide decision support information on digital curricula and online classes

The Arizona Telecommunications and Information Institute (ATI Institute) partnered with Microsoft Corporation and their Shape the Future team to have a Digital Inclusion Economic Impact Model for Arizona executed by their partner The Arnold Group at no cost to ATI Institute or the State. The model is designed to measure the economic and social impact of digital inclusion initiatives and has been performed across the U.S. in five states and seven cities to date.

The Digital Inclusion Economic Impact Model was run based on a variety of Arizona data provided. The model's target segment consists of disadvantaged school-age children and their families as this group has the greatest long-term effect for the realization of the benefits. Arizona modeling results indicate that students with a home PC and broadband access increase their chance of graduating from High School by 6-8 percentage points and experience an average increase of $1.2M in additional economic and social impact over their lifetime. The affected individuals will also have more employment opportunities benefiting from significant lifetime creation of jobs. By targeting students in poverty, over $32.4 billion in total lifetime

economic and social impact can potentially be realized.

- **Facilitate the provision of access to digital curricula to the education community and student and workers homes**

There are an enormous number of online learning classes, classroom supplemental materials and professional development tools available. (Rivero, 2011) IDEAL should host the eLearning knowledge center to have a one-stop location for both decisions as well as access.

Project Tomorrow has created annual reports since 2007 on trends in education. In their latest report released on June 26, 2012, their findings included: A majority of teachers, school site administrators and district level administrators now report participating in an online class for their own professional development. For teachers, this is an increase of 148% since 2007. Thirty percent of teachers say that online professional development is their preferred approach for continuing education. A positive correlation exists between educators' experiences with online learning and their interest in mobile learning in school. (Project Tomorrow, 2011)

Vail Unified School District created an innovative program called Beyond Textbooks. Vail is the number one rated school district in Arizona. Every one of its schools has earned the designation "excelling." (Werr, 2010)

Beyond Textbooks is a successful comprehensive education program. Vail is partnering with approximately 70 school districts and schools in Arizona who are using the program. One of the most impressive aspects to the Beyond Textbooks instructional program is the curriculum framework and calendar of the standards linked to resources and assessments online. (Vail School District, 2012)

Arizona's State Library hosts a major website with enormous amounts of free information and materials, including subscriptions to articles and journals. (ASLAPR, 2012) This comprehensive online library provides digital curricula links to students and workers in their homes.

- **Support development of state supported technology and digital curricula literacy programs for both students and teachers**

- **Encourage implementation of training programs for teachers on how to use digital curricula and distance learning to effectively transform classrooms to an e-learning model**

None of these resources are of much value unless educators and trainers have developed their practice to effectively use the full potential of eLearning. The chicken-egg issue is that all this technology must be in the learning environment to effectively learn an eLearning teaching practice. 70% of Arizona's teachers in 2006 did not meet the state's own Technology Competency Standards for Teachers. (US Dept of Education, 2009)

A second complicating factor is that in both pre-service and in-service environments the teacher/trainer eLearning savvy level will run from novice to expert.

A third challenge is the current level of investment for in-service human resource development. Teachers, professors, educators, and trainers are the new high-tech workforce. As such they must be afforded the same level of education, training and professional development in the use of eLearning systems and pedagogies as our other high tech workforces are given. The typical annual investment by Boeing or Intel is between $1000 to $3000 for their engineers and technicians. The last reported figure in education is $100 to $300. (Citation pending)

Arizona's 70,000 teachers, classroom aides and instructional support cadre is transforming from legacy education to eLearning. Their initial professional development needs are greater than a technology based industry making marginal changes each year.

- **Organize to provide assistance to small school and library districts in making E-rate applications**

- **Support policies to ensure that all youth become proficient in workplace skills including lifespan eLearning skills during their time in school**

- **Support community institutions that support informal learning in after school programs and job training**

"Extending the school day" through after school programs is a big plus in educating students. (McClintock & Michelle Gayles, 2012) The California digital plan encourages educators to connect to such programs through boys and girls clubs and YMCA's and YWCA's and other similar types of organizations. (The California Broadband Task Force, 2008)

Scottsdale Boys and Girls Clubs (SBGC) have a well-developed after school education program that has research results that show positive improvement. They connect the Internet2 advanced IT network to the Vestar branch. This chapter won the national outstanding branch award last year. (Boys and Girls Club, 2012)

- **Foster partnerships with community institutions that provide technology access and transition services support to students with disabilities and other special needs**

Community institutions provide specialized services to Arizona's special needs students, who are about 1% to 2% of Arizona students. Some services are part time and some are residential. (Boys and Girls Club, 2012) The use of eLearning technologies has been pioneered for decades with these students and many advances have been made. (Boys and Girls Club, 2012)

- **Assess state and local statutes, rules and regulations and determine which are barriers to adoption of 21st century education and workforce practices and provide recommendations for changes**

One of the benefits of the online learning aspect of eLearning is that it opens up a world of potential teacher facilitated, but student driven, learning experiences. However, under current Arizona law an out of state university professor with a Ph.D., cannot legally teach K12 students for credit. (Citation pending) Well-intended and beneficial incremental changes to state statutes have produced a complex mess with many conflicts, obsolete statutes, barriers to student learning, and unintended consequences. Many requirements need to be changed to reflect eLearning in education.

Recommendation #7: IMPROVE HEALTHCARE

Like a person suffering from a debilitating disease, healthcare delivery in the United States is ailing. The U.S. spends significantly more per capita and a higher percentage of GDP on healthcare than other developed nations, yet our patient outcomes (e.g., mortality, safety, access to medical care) are disparate and inconsistent. Moreover, the rapidly rising costs of healthcare delivery are making medical care increasingly unaffordable to the average citizen and threaten our national financial viability. Not unlike a very ill patient on life support, this confluence of issues requires immediate attention and action. Something needs to be done to fix the American healthcare delivery system; it is not sustainable in its current form. [From "A Roadmap to High-Value Healthcare Delivery" by Cortese and Smoldt]

(Cortese, 2012)

Facilitate the expansion of a robust statewide telehealth ecosystem

Twenty five years ago all a doctor needed was a telephone with dial tone. Today a doctor needs enough bandwidth for real-time collaboration while viewing MRIs.

Healthcare is 18% of our nation's GDP and will cross 20% before 2020. In 2040 there will be twice as many Americans over 65 as there are now. Three-quarters of America's health costs are for chronic conditions. There will be physician shortages as this generation of doctors is retiring. (FCC, 2010, p. 199)

Heath Information Technology (HIT) can reduce costs, increase physician productivity, and improve care:

- e-prescribing can catch harmful drug interactions.

- Testing results can be done faster with less errors.

- Vaccination reminders should save some 39,000 lives a year.

- Video consults can speed the decision to administer clot-busting drugs for stroke victims.
- The American Heart and American Stroke Associations recommend them.

- Rural patients could have remote access to medical specialists in urban areas.

- Telepsychology and telepsychiatry can allow patients to do sessions remotely.

- Emergency room visits for nursing home patients and even prisoners should be reduced.
- Savings are estimated at $1.2 billion a year.

- Physicians can receive medical testing data on patients quickly through their phones if away.

- Sensors can be used to monitor diabetics remotely and dispense the correct insulin electronically.

- Heart patients can be monitored remotely. (FCC, 2010, pp. 201-203)

The FCC adopted new rules in May 2012 making the U.S. the first country in the world to dedicate spectrum for Medical Body Area Networks – which enables advanced health monitoring that will improve the quality of care, lower costs, and ultimately save lives.

Previously, the Commission dedicated spectrum for Medical Micropower Networks, which has the potential - literally - to enable paraplegics to stand. (Genachowski, 2012)

There are many other applications, but none of them can work without the proper digital capacity.

Deployment of robust digital capacity will enable near real-time access to patient records for hospitals, offices and homes. Statewide efforts to increase electronic medical record (EMR) adoption and health information exchanges (HIE), rely on high speed, mobile Internet that is often lacking in urban and rural environments. Applications are critical to reduce over-utilization related to redundant ordering practices so prevalent in healthcare today. Information in real-time is critical for appropriate, cost-effective, medical decision making. (FCC, 2010, p. 209) Quality video consultations require 6 Mbps upload and download. Even greater bandwidth to transmit new technologies such as 3D imaging will become important. (FCC, 2010, p. 209)

Beyond data there is more opportunity enabled by SB 1402. Healthcare is typically thought of as the process of diagnosis and treatment of disease, both data driven endeavors. This neglects one of the primary drivers of the healthcare economy - worry. When we are sick, we need reassurance. When this is not immediately available to the patient, the nurse or the generalist, bad things happen. We tend to seek answers and help through tests and patient transfers. We are required to elevate the level of care, often with no real long-term value to the patient. Knowing answers sooner can help reduce unnecessary worry and cost.

- ## Facilitate the development of infrastructure to support healthcare messaging, health monitoring and health collaboration

It is widely accepted that technology is one way to deliver better or cost effective healthcare. Although Electronic Medical Records (EMR) and Health Information Exchange (HIE) are part of this solution, there is a value leak if information is not shared with the right people at the right time. The Digital Arizona Council works to support infrastructure for healthcare messaging, health monitoring and health collaboration.

Healthcare messaging among care providers is currently archaic. The paging system was developed in the 1950's. This system has remained the primary way the medical industry communicates with each other. This limits the ability to deliver the right provider at the right time or even to actually find that person. There are many modalities where physicians and other healthcare providers could message each other more robustly. Outside of the pager there is e-mail and cell phones which are now relatively ubiquitous. The message ties back into emergency preparedness, as well as routine clinic care.

Health monitoring can refer to patient monitoring and is relevant in multiple arenas. One of the more interesting opportunities that now exists is to provide electronic monitoring devices as a part of an Enhanced Intensive Care Unit (EICU), such as that being deployed at Banner Healthcare System. They have approximately 500 patients who are actively monitored and experiencing better outcomes compared to a routine ICU. This is somewhat counter intuitive but it has been demonstrated with data. Monitoring can be extended so that we include our most expensive patients. Patients at home who need to have monitoring for weight, blood pressures and blood glucose can allow active

bandwidth to be deployed so that these patients may stay at home and on task, improving overall patient health and reducing costs.

Health collaboration is defined as the opportunity to put a care team together for a given patient. The federal government has come forward with recommendations to have shared risk and wellness for patients as opposed to transactional medicine. Care teams allow a multitude of people to be engaged in the overall health of patients, improving their care and reducing costs. Collaboration does not require video transmission in all circumstances. However, there are many times when video is an absolute requirement. Video transmission can present opportunities to best understand the patient and to develop a relationship with that patient. Without video, physicians and other healthcare providers cannot achieve a level of relationship required in a medical environment.

- **Support the expansion of electronic health records (EHR) exchange and Health-e Connections**

To date, telemedicine has been limited by a number of factors, not the least of which is the lack of ubiquitous digital capacity. Medical images can require higher bandwidth. SB1402 provides the infrastructure to begin the conversations and application deployment to enable the right provider to care for the patient in near real-time, to provide reassurance while still at home or office rather than requiring transfer. (FCC, 2010, p. 209)

Figure 9: The Arizona Health Information Exchange

(Arizona Governor's Office of HIE Exchange, 2010)

The use of EHR can improve patient care by giving providers more complete and timely patient information to make well-informed decisions quickly and safely. For example, an EHR can identify

the patient's drug allergies and drug interactions. The system can provide vaccination reminders. Patients can be monitored remotely for early detection. (FCC, 2010, p. 193) The U.S. ranks near the bottom in nearly every category used to gauge the adoption of EHR among 11 developed countries. (FCC, 2010, p. 193)

The federal government is spending significant funds to help create the use of EHR technology. Physicians can earn extra money by using EHR with Medicare and Medicaid. There are other financial incentives which give way to penalties by 2015. (Center for Medicare and Medicaid Services, 2012)

This program is called "Meaningful Use" and is an actual set of standards created by the Centers for Medicare & Medicaid Services (CMS) Incentive Programs that governs the use of electronic health records. The benefits of the meaningful use of EHRs include complete and accurate information, better access to information and patient empowerment.
(Arizona Governor's Office of HIE Exchange, 2010)

The three major challenges for EHR are adoption, use and connectivity. Connectivity is where the Digital Arizona Council can help most. Other initiatives are underway to create an EHR initiative in Arizona. There are many involved in this process. (Arizona Governor's Office of HIE Exchange, 2010)

Arizona Health-e Connection manages the "Regional Extension Center" grant which is focused on EHR adoption and utilization. ASET manages the "Health Information Exchange Cooperative Agreement Grant". Both are ONC programs and are closely linked together. ASET's focus is to "enable" and jumpstart health information exchange in a variety of ways including both "pull-based" exchange and "push-based" exchange. The Health Information Network of Arizona is also an active participant in this process.

- **Facilitate the attraction and support of advanced health information initiatives such as the Institute for Advanced Health**

Arizona benefits from a number of large and prestigious healthcare providers that can provide a backbone for a successful health information initiative.

The Chan Soon-Shiong Institute for Advanced Health (CSS Institute) "assumed financial responsibility" for the National Lambda Rail in July 2011. The Institute's founder, Patrick Soon-Shiong, M.D., wishes to use this intranet network also as a secure "medical information highway." (Institute for Advanced Health, 2011) This includes advanced bioinformatics research, a health grid, and the creation of a national health information network.

The NLR is a 12,000 mile advanced optical network that goes through Arizona. The University of Arizona and Arizona State University are members. The NLR has a new supercomputing center near the Phoenix Airport and another new significant facility in Scottsdale, and plans for more development near the Phoenix Airport. (Institute for Advanced Health, 2011)

The NLR has 280 research institutions and federal agencies as members. Speeds of up to 100 Gbps are possible. (Institute for Advanced Health, 2011)

"The Iowa Health System peers with NLR at the Starlight facility on Northwestern University's Chicago campus so that its hospitals and clinics in over 70 communities in Iowa, Illinois and Nebraska can securely and reliably connect with data and specialists elsewhere in the U.S.

and in other countries." (NLR, 2009)

There are partnership opportunities with the NLR that should be investigated by those involved in creating the EHR initiatives for Arizona.

The challenge is to bring together all the many stakeholders in creating a HIE. This includes hospitals, physicians, insurers, patient advocates, healthcare workers, government health agencies and others.

The Governor's Office of HIE (migrating to ADOA ASET oversight) should continue to lead this effort.

• Foster sustainable e-health business models

Currently the Centers for Medicare and Medicaid Services reimburse approximately $2 million in telehealth services out of an annual budget of over $300 billion. (Tapper, 2012)

Finding sustainable e-health business models is a challenge. For example, there is no common lexicon for coding in virtual space. Medical facilities and doctors utilize medical codes for every procedure for which they seek reimbursement. Telemedicine provides opportunities for new ways to practice medicine and reimbursement formulas and codes need to be devised and standardized.

Strong payer involvement is needed in expanding and simplifying reimbursement. The health insurance community on the government and private side will be essential to making such a system workable. These efforts are often overlooked by the providers of care. These efforts should include associated downstream revenue with improved worker productivity.

Additionally Arizona's universities can be a model of this new medicine and are encouraged to offer virtual services for their students and employees rather than strictly brick and mortar clinics. Medicaid has been responsive to creating medical insurance reimbursement codes for telemedicine.

• Encourage the use of medical expertise wherever it exists (licensing issues)

The DAC encourages emergency preparedness in the healthcare space via messaging, monitoring and collaboration. This could be in conjunction with other process and could be directed out of the office of the Arizona Chief Information Officer (CIO).

Current medical licensing restrictions impair the use of telemedicine. Hospitals are credentialed and when they are treating patients they serve as the responsible party. However, when a patient is in one hospital and utilizing the telehealth services of another hospital the credentialing and reimbursement rules collide.

This issue is very important to rural hospitals that face particularly challenging financial conditions. When rural patients in Arizona do not use their local hospitals but instead go to urban hospitals revenue is lost. If rural patients can use their local hospitals and healthcare facilities they can still have access to specialists when needed through telemedicine. Telemedicine produces more revenue for these rural hospitals and in many cases avoids unneeded transportation.

Should it be required, many medical tests can be performed at rural hospitals and the results transmitted to specialists. With current technology scope results, MRI's, scans, and x-rays can be

diagnosed via telemedicine channels to provide both emergency and second opinion support.

A new ruling allows for urban and rural co-credentialing based upon relationship agreements. (Citation pending) Avenues to simplify urban-rural relationships for licensing and credentialing should be supported, such as reciprocity. There should also be improved reimbursement and visibility for telepsychiatry and other behavioral medical services statewide.

- **Facilitate the implementation of a shared vision, strategic plan and sustainable business model for the health network**

- **Leverage the Digital Arizona Council to ensure progress and accountability for telemedicine**

- **Facilitate the expansion of existing telemedicine and e-health networks and initiatives that have shown success**

One company in Arizona that is pioneering this work recently won the North American E-Health Service Company Award of the Year. Their market niche is dealing with some 66% of patients who visit emergency rooms but do not need to. This new concept is essentially a replacement for the traditional home doctor visit. (Stat Doctors, 2012)

One simply registers an account and once an individual is registered they can call and connect live with board certified emergency room physicians. You can use your traditional phone or smart phone. They have a virtual waiting room that tells you how long your wait time is. (Stat Doctors, 2012)

There is an entire new field emerging called mobile health. This system allows physicians to monitor patients remotely through communications networks at all times. Physicians who are not at the office can review test results, pharmaceutical information, and diagnostic data using Personal Data Assistants (PDAs) and Smartphones. Emergency Medical Technician (EMT) responders use field laptops. Sensors can be used that are non-invasive to track present time health information such as the patient's heart or sugar levels. (FCC, 2010, p. 18)

The Veterans Administration has a successful model it uses with some 32,000 veterans with chronic conditions. This national program is called Care Coordination/Home Telehealth. The average cost each year per patient is $1,600. The Veterans Health Administration home primary care costs $13,121 a year. A nursing home costs the VHA $77,745 per year. (Darkins, Ryan, Kobb, Foster, Wakefield, & Lancaster, 2008, p. 1123)

- **Support mechanisms for sustainable e-health networks**

Downstream revenue and job creation in rural areas will evolve telehealth. This will create jobs. (Monegain, 2010) Some 18.2% of the nation's GDP was healthcare in 2011. (Brandt, 2012)

Arizona has had recent major success with its Medicaid program leading an effort to create payer codes for telemedicine. (AHCCCS, 2012) This is a breakthrough and came about in part through conversations with the DAC.

The major barrier now is Medicare, which currently is not making changes needed to advance a sustainable e-health network. Medicare's rules are currently outdated. (ATA, 2011) Without Medicaid and Medicare as leaders and major drivers of e-health networks and new reimbursement models

and available codes for Telehealth a sustainable business model for this new form of medicine will not be created.

- ## Encourage increases in the availability and use of e-health applications

Telemedicine is an entire new way to practice medicine. (Herrick, 2007) It was not taught in medical school and payers have never dealt with it before on a large scale. All stakeholders should add to their skill sets and be able to provide telemedicine services.

It is wonderful to have a doctor speaking to a patient face-to-face, but in this age of technology, this same conversation can take place on a video conference call, with the doctor reading the chart, speaking to his patient hundreds of miles away. It is difficult for top notch specialists to afford to relocate to smaller communities, and it is not an efficient use of resources to send specialists to remote areas even on a weekly or bi-monthly basis. But having them literally a video call away improves the quality of life, can present unnecessary trips via ambulances and helicopters and save lives. (Satava, 2007)

The Arizona Health Care Cost Containment System (AHCCCS) needs to encourage telemedicine. AHCCCS has been very forward thinking in its expressed support of face to face, whether in person or virtual. It will pay via the same codes. However, few healthcare providers know about the new codes and education needs to take place to make telemedicine successful. By not moving the patient (lowering the barriers for access), compliance goes up, and costs go down long term. This has an indirect benefit. Rural care centers are the economic backbone of many rural communities. Every time a patient leaves their community for services in the city, money leaves with them. Supporting this model and keeping patients local can be an economic driver for jobs in rural Arizona.

- ## Encourage the removal of barriers for appropriate reimbursement by health plans
Reimbursement plans for telemedicine are not adequate to ensure sustainability. (Herrick, 2007) (Tapper, 2012) The payment policies are unclear and confusing. This discourages others from using Telehealth.

- ## Improve the capacity to provide e-health to everyone everywhere

One of the best ways to increase e-health is to go where the patients are. Local schools are ideal locations as healthcare centers. The office is another location. Arizona should use state resources such as schools and libraries to become centers of wellness.

Bringing together digital providers from the office, parents from work and children from school will avoid costly travel and diminished productivity typically associated with frequent clinic visits required for those with chronic conditions. Those who do seek regular healthcare will now have a much easier opportunity to obtain it.

Care transitions are the future of healthcare. Moving from home to hospital to nursing home to home all represent a distinct opportunity to improve care and lower costs. The payers are currently looking for ways to improve these transitions. Unfortunately, the hand offs are never clean - people don't get their medicines, they don't remember what they are supposed to do, they feel alone. Reassurance, enabling presence for the family to see a provider or a home health nurse to see a doctor, means that care can begin in the home, not on return to the hospital. This lexicon of care transitions and reassurance will resonate with the hospitals and payers. They need to be brought into the ecosystem.

Encourage families to get involved with the care of their loved ones, being "present" during healthcare encounters. Ultimately, much of the responsibility for care falls to the family who are

currently disconnected (via distance) from the care of their loved one. The healthcare ecosystem is made up of all those who care about the patient - not just practitioners.

Organizing healthcare centers at K12s and other public facilities will take the combined leadership of schools, library officials, government officials, healthcare providers and state healthcare leaders. An existing structure should be found to effectuate this, or an existing one should be utilized.

- **Support concepts and language that ties in public safety, first responders and ongoing care**

- **Encourage guidance on payer codes and a common lexicon for coding in the virtual space**

Figure 10: Arizona Telemedicine Network
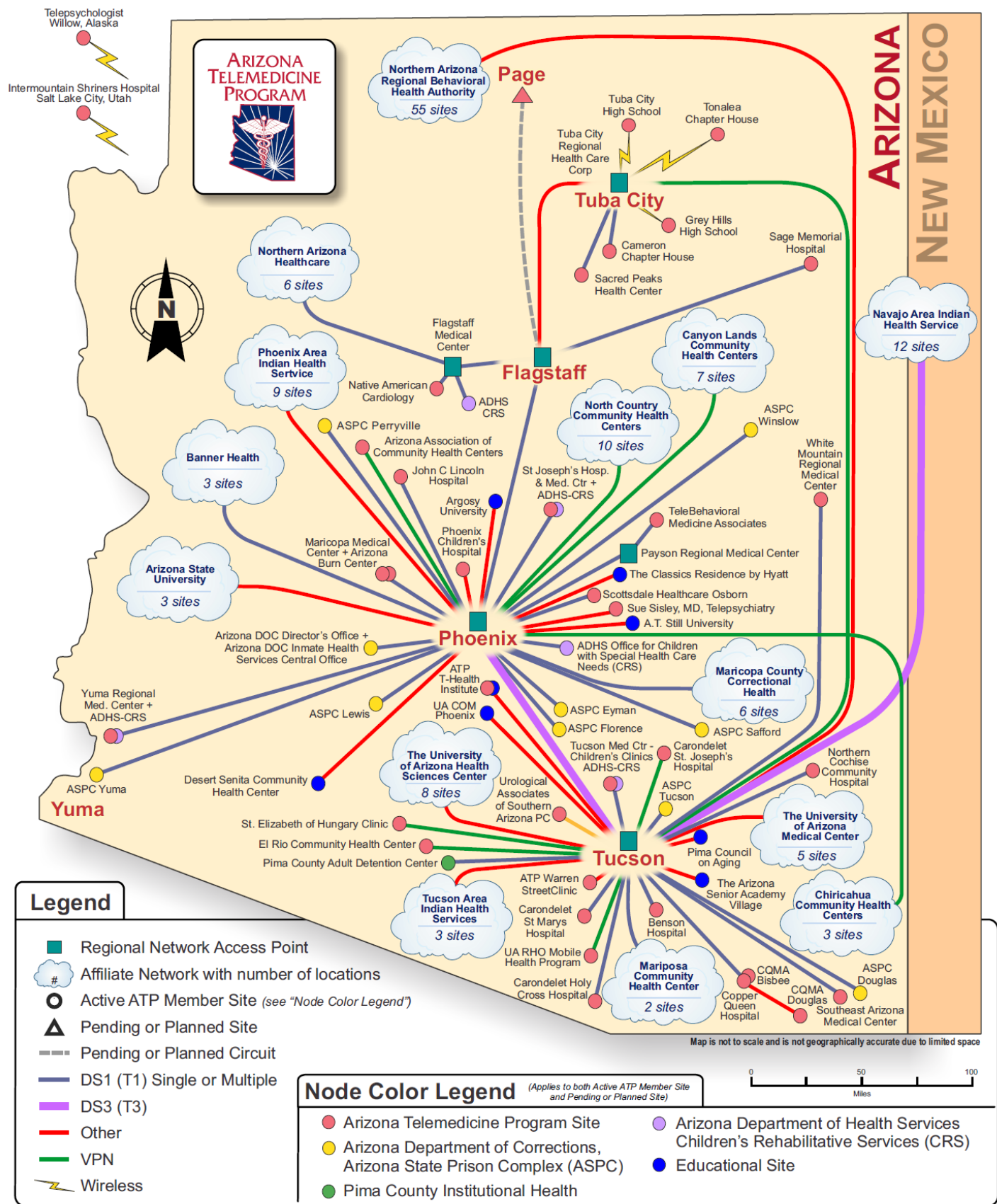
Recommendation #8: ADVANCED RESEARCH

Catalyze and enable an environment of discovery, innovation and research

Advanced research and development in science today depends increasingly on transmitting massive amounts of data through interconnecting high-performance computing arrays. Super-high-speed network capacity allows scientists and researchers to collaborate from a distance. Arizona needs these kinds of advanced networks available in strategic areas of the State such as universities and surrounding research parks, and other high-end research facilities.

Future innovation and discovery in healthcare, genomics, proteomics, biology, physics modeling, aerospace engineering, astronomy and national security will depend heavily upon the availability of high capacity networks. The states and nations that have the best networks will lead in discovery and the resulting economic benefits.

- **Identify big data and telepresence high impact areas and application domains that are most likely to enhance existing strengths.**

90% of the world's data has been created in the last two years. (IBM, 2012)

The world's largest genomic research institute is the Beijing Genomics Institute in China. They produce some 2,000 human genomes in a day. Its data is so massive that it takes weeks to transmit it over a normal Internet. (PCMag.com, 2012)

Big data is also big business. Imagine analyzing hundreds of billions of meter readings to improve power consumption. Tracking hundreds of millions of trades each day looking for fraud. Analyzing12 terabytes of Tweets each day to improve product sentiment. (Pollack, 2011)

The Big Data Revolution in Arizona is being led by the state's universities and other research institutions including the Translational Genomics Research Institute (TGen) in Phoenix, and the NLR that is under the financial responsibility of the CSS Institute.

The NLR has a new supercomputing center in Phoenix and another major facility in Scottsdale. The first K12 in the world to utilize the NLR for telepresence education is in Arizona. (NLR Blog, 2010)

The upgraded network will have an unprecedented 8.8 Terabits of capacity and use brand new 100 Gigabit Ethernet technology. The Internet2 Network is the first national network to deploy 100 GigE waves on its entire footprint, and will become the most sophisticated research and education platform in the world." (Internet2, 2012)

- **Facilitate Arizona becoming a world leader in high bandwidth medicine including genomics and proteomics, building on existing biotech and healthcare strengths**

Arizona is in an extraordinary situation to position itself as a world leader in high bandwidth medical research. With its existing assets and population base it can leverage itself to become the bandwidth medicine leader to benefit Arizonans and the rest of the world.

From the Biotechnology Industry Organization's State Bioscience Industry Development Study in partnership with Battelle, "Arizona's bioscience industry continues to grow at a rapid rate. Industry firms have increased employment by 30 percent overall since 2001 (through 2010) and have even added jobs since 2007, a period which includes the deep national recession. These growth rates continue to outpace those for the national bioscience sector. Since 2001, all five major subsectors

have experienced net job growth in the state, led by research, testing, and medical labs which has grown its employment base by more than 50 percent since 2001. The State is well concentrated in bioscience-related distribution with a location quotient of 1.10." (Battelle and BIO, 2012)

The world class TGen is in Phoenix, Arizona. TGen conducts experiments today that were impossible a few years ago. TGen is a nonprofit organization that was founded in 2002 by Dr. Jeffrey Trent, who was the founding Scientific Director of the National Human Genome Research Institute. Arizona is fortunate that Dr. Trent located TGen here. Arizona governments provided incentives to TGen to headquarter in this state. (TGen, 2012)

When the impact of TGen-generated business spin-offs and commercialization are included, the study shows, TGen in 2010 produced $25.04 for every $1 invested, supported 1,124 jobs, generated $10.1 million in state tax revenues, and $137.7 million in total annual economic impact. (TGen, 2011)

One of the fastest computer data-processing links dedicated to aid such biomedical research has been implemented between laboratories at TGen in Phoenix and the facilities of the High-Performance Computing Initiative of the ASU Ira A. Fulton Schools of Engineering. (TGen, 2010)

Using a supercomputer called Saguaro 2, ASU computer engineers are moving voluminous amounts of information to TGen researchers at as much as 100 times faster than previous systems. The new system is capable of quickly processing trillions of bits of DNA information. It will allow TGen scientists to accelerate the analysis of next-generation whole genome sequences - readouts of the entire three billion chemical letters in an individual's DNA. (TGen, 2010)

The Mayo Clinic is one of the top medical practice and research groups in the world. It has three main locations including Scottsdale/Phoenix, Arizona. It employees some 5,000 people in the state. (Wikipedia, 2012)

Mayo is an ideal partner to conduct clinical trials of TGen discoveries. Although in its infancy, many scientists and clinicians believe that Whole Genome Sequencing (WGS) holds great promise as a therapeutic decision making tool, much the way X-rays became a powerful tool for informing diagnosis and treatment of a wide spectrum of diseases in the early 1900's. (TGen, 2011)

WGS provides a macro view of an individual's complete genome - spelling out the DNA code of all 3 billion chemical bases - in both its healthy and disease state. This ultra-DNA analysis may soon become a standard part of treatment, rather than an exception. (TGen, 2011)

Last year, ASU announced it is relocating its biomedical-informatics program from downtown Phoenix to Mayo's Scottsdale campus. Mayo Clinic also will team with ASU on a new Mayo medical-school branch in Scottsdale that can begin teaching students by 2014. (Alltucker, 2012)

ASU School of Biomedical Informatics programs is being jointly developed with Mayo Clinic. The ASU-Mayo collaboration will include data on genetics, clinical and imaging and public health. (Flinn Foundation, 2011) ASU has bolstered its ties with Mayo Clinic on several fronts over the past decade, such as nursing education, research and dual-degree programs. (Flinn Foundation, 2011)

The University of Arizona Genetics Core (formerly known as GATC) offers access to state-of-the-art resources and services to help investigators, educators, students and the biotech community conduct and promote research in the field of genomics. (UAGC, 2012)

TGen North is the heart of TGen's Pathogen Genomics Division, led by Dr. Paul Keim, one of the world's foremost experts in anthrax and other dangerous infectious diseases. Dr. Keim is a professor of biology and the Cowden Endowed Chair in Microbiology at Northern Arizona University. The strategic plan for TGen North has been developed to focus on diagnostic, analytic, forensic and

epidemiologic research related to pathogens important to medicine, public health and biodefense. These activities are linked across TGen North's four research centers: 1) Center for Public Health and Clinical Pathogens; 2) Center for Microbiomics and Human Health; 3) Center for Dangerous Pathogens; and 4) Center for Pathogen Information. (NAU, 2007)

Barrow Neurological Institute (BNI) is a worldwide leader in neuroscience diagnostics, pioneering treatments and research into complex neurological diseases and conditions. The Institute attracts patients, students and medical staff from all over the United States and more than 100 different countries. BNI is a leader in graduate medical education, and directs the largest neurosurgery residency program in the country. It also is consistently recognized by U.S. News & World Report as one of the country's top hospitals for neurology and neurosurgery. BNI is a part of St. Joseph's Hospital and Medical Center in Phoenix, Arizona. This healthcare system conducts nearly 1,000 clinical trials. (BNI, 2012)

The Children's Health Center-BNI-TGen Pediatric Neurogenetics Center (Center for Excellence) is located at the Children's Health Center, St. Joseph's Hospital and Medical Center. (TGen, 2005)

The BNI-ASU Center for Preclinical Imaging is a unique, National Institutes of Health (NIH)-funded imaging resource that is available to all academic and institutional biomedical researchers. The center brings together the leading imaging scientists in the Phoenix metropolitan area and their counterparts in all areas of biomedical research.

The mission of the BNI-ASU Center for Preclinical Imaging is to provide state-of-the-art imaging technology and expertise to researchers in and around Phoenix, Arizona. Key to that goal is their advanced preclinical MRI machine. The Center is a joint effort between BNI and ASU with the goals of providing a key piece of core technology to area researchers to advance biosciences across Arizona.

Together these research institutions provide the foundation for Arizona to be a leader in the use of high bandwidth medicine.

The State's role can be to continue to provide the incentives for current and prospective research institutions to do business in the state. The State can and should promote ultra-high-speed connectivity between these research institutions and collaborators outside the State with the goal of 100 Gigabit technology connections. This high bandwidth will enhance current research efforts in the State and bring incentives for other research institutions to start, expand or relocate in Arizona.

- **Work towards the creation of two to three Gigabit Development Zones in Arizona with gigabit availability at affordable prices to drive experimentation, innovation and economic growth through digital capacity**

 "….networks are now the common medium for international research, for American research universities to continue to lead the world, it is not enough for the networks they use to be world-class; they must be world leading." (Gig.U, 2012)

The natural location for these zones are in and around the state's major universities and near major research centers such as TGen in Phoenix, the Mayo Clinics in Scottsdale, and the University of Arizona College of Medicine in Tucson.

The City of Phoenix, ASU and the Mayo Clinic are jointly planning an "Arizona Biomedical Corridor" based on a memorandum of understanding signed April 3, 2012. This corridor will be in northeast Phoenix in and around the Mayo Clinic at 56th Street and Mayo Blvd, south of the Loop 101 freeway. The goal is to establish a major bioscience center in northeast Phoenix. "The corridor will

accommodate biotechnology companies, clinical and academic uses and supporting commercial development." (ASU, 2012)

A goal should be to establish the areas in and around Arizona's three major universities as Gigabit Development Zones. In rural Arizona, Payson is hoping to set up an ASU campus in Payson with an onsite student component, but also a significant international student body through online learning which might well justify an ASET/ADOT pilot project with conduit placed along the Beeline Highway (Arizona 87). Also, core biotech, medical, and healthcare industry centers would provide excellent prospects for Gigabit Development Zones such as the downtown Phoenix Biomedical Campus (http://phoenix.gov/econdev/reinvest/focus/) and the planned Arizona Biomedical Corridor at Desert Arizona

- **Facilitate the definition of and support high-performance digital initiatives for innovative programs to advance university research, industry collaboration, learning and biotechnology**

Figure 11: National Gig.U Participants

(Levin, National Gig.U Participants, 2012)

Figure 12: Greater Lansing Gigabit Development Zone Example
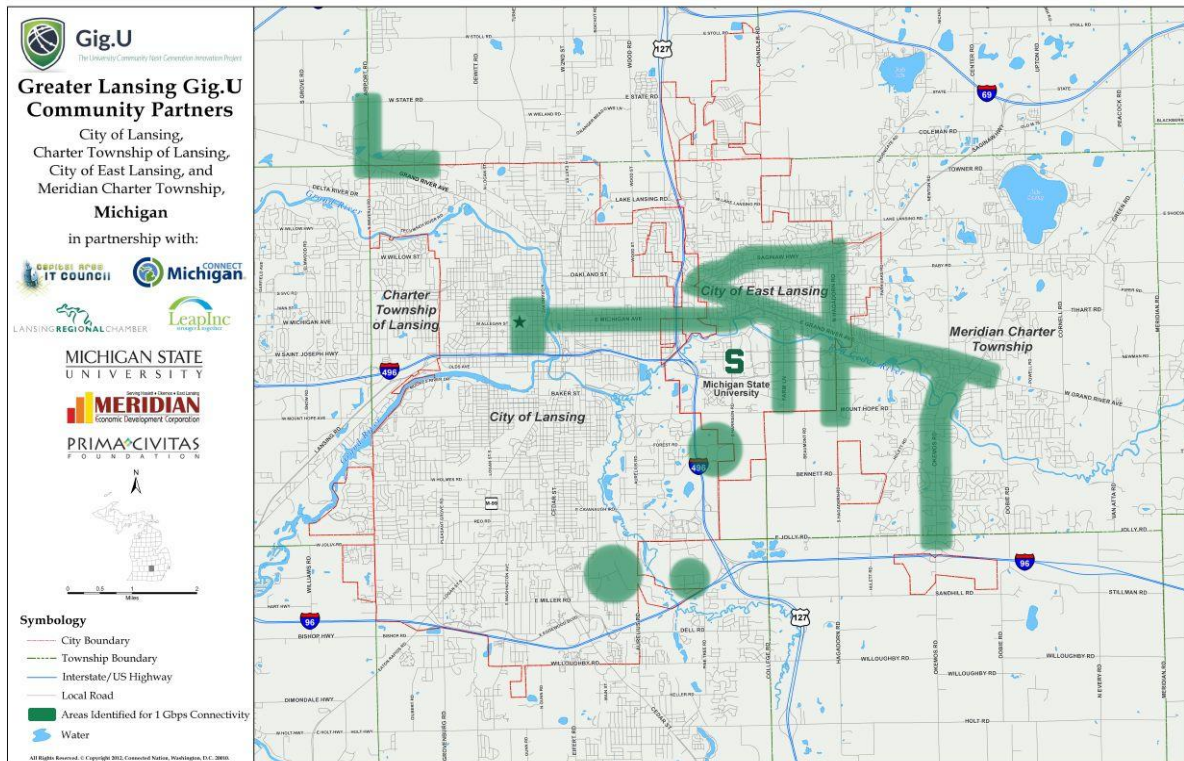
(Levin, National Gig.U Participants, 2012)

Recommendation #9: PUBLIC SAFETY COMMUNICATION

Support and align with the public safety community in enhancing and leveraging broadband operations and communication capabilities

The entire public safety communications landscape changed dramatically with the passage of Public Law No: 112-96 on February 22, 2012. This legislation created the First Responder Network Authority (FirstNet) that will be responsible for the creation and maintenance the National Public Safety Broadband Network (NPSBN). (Strickland, 2012)

States will be responsible for working with FirstNet to develop the definition of requirements for their state's portion of the NPSBN within the context of the national architectural design. FirstNet will be taking each state's input, while managing to the overall budget and returning with a plan for the state's portion of the buildout. (NTIA, 2012)

The network is required to be self-supporting following a fee-based business model. There are also ample opportunities for the sharing of both spectrum and hardware (tower space, conduit, etc.) in public/private partnerships to bolster the net-zero financial model (NTIA, 2012)

Although it is speculation at this point, it seems reasonable that the shared use of the state and local infrastructure assets may be used as an "in-kind" credit for either greater coverage or reduced network fees.

This will present valuable opportunities for funding, network infrastructure and maintenance support. However, there will be constraints as FirstNet works through the issues of:

- Who can be on the network (specifically the wireless D-block spectrum, which is reserved for Public Safety);
- Policies and standards surrounding dynamic and preemptive priority on the D-block spectrum; and finally
- Defining what forms of public/private partnerships are acceptable.

Each of the following actions needs to be considered in the context of the overarching FirstNet architecture and governance. Also, with respect to the sharing of infrastructure, the most likely opportunities will center on fiber or microwave backhaul due to the security and reliability concerns about tower space. Therefore these actions are focused primarily on the fiber backhaul aspects.

- **Involve State agencies including the Department of Public Safety (DPS), Public Safety Interoperable Communications Office (PSIC), and Department of Emergency and Military Affairs (DEMA), as well as 9-1-1 public safety telecommunications entities, counties, cities, special districts, fire and law enforcement associations, and other public safety stakeholders in working together to create a digital capacity blueprint for future communications coordination and interoperability.**

Coordination for this major project rests with ASET's PSIC Office. The PSIC Office is responsible for "advancing interoperable communications in Arizona" and it provides staff support to the Public Safety Communications Advisory Commission (PSCC) and the SIEC. (PSIC, 2012) In addition, the PSIC Office has been identified as the single point of contact for interactions with FirstNet.

PSCC's voting members represent a cross section of public safety stakeholders at the State and local levels. SIEC has done much planning in the area of interoperability. The grant dollars that potentially come to Arizona from FirstNet are in the tens of millions. While it is an extraordinary opportunity to advance the interoperability of the public safety systems in Arizona, a great deal of planning will be involved.

- **Identify and support technological and policy solutions that promote the sharing of public safety infrastructure, where possible, to not only create an interoperable and robust communication system for Public Safety but also provide that infrastructure for other uses.**

SB 1402 provides an ideal opportunity to promote technical solutions for interoperability while supporting infrastructure for other uses. This legislation allows conduit to be buried along state rights-of-ways and can speed up dramatically the lengthy and costly permit approval process.

The legislation and policy allows multiple providers to utilize the same trench for their own conduit separated by protective tubing. This turbocharges the impact of the SB 1402 legislation and allows badly needed digital fiber to reach rural Arizona for public safety and a host of other digital uses such as eLearning, telemedicine, government, individuals and businesses.

- **Drive digital infrastructure deployment to become more robust, redundant, and resilient over time to expand capacity for advanced applications and minimize the potential for interrupted service across the State**

Fiber provides enormous capacity for digital buildout. As noted earlier, Arizona has a digital middle mile infrastructure with dead-ends that do not interconnect. Interconnection or redundancy allows transmissions to reroute themselves when there is a transmission break. Building this interoperability system across Arizona will create more redundancy in the state's interoperability system.

- **Continue to work with the Public Safety Interoperable Communications Office by providing assistance in the development of state and local policies, standards and procedures necessary to achieve wireless interoperability in Arizona**

ASET's PSIC is the natural "lead entity" to bring together the policy leadership. This is their legislative mission. Additional state digital expertise is within ASET at the DAP, which is coordinating SB 1402 implementation. Finally, statewide 9-1-1 management resides within ASET, so coordination will be streamlined.

- **Coordinate and align with the Public Safety Interoperable Communications Office in continuing to provide educational opportunities, grant preparation assistance and technical consultation to public safety programs seeking federal interoperability and modernization grants**

PSCC has provided technical consulting on over 30 federal interoperability grants. It can continue providing this support. A potential risk is a low adoption rate because the program is fee based.

Arizona received over $75 million in digital grants under the ARRA funding. Some of these grants have a public safety interoperable mission and it is possible they can be leveraged in the creation of such a network.

It is likely that the cost of creating a FirstNet network in Arizona with the federal funding that is available is not enough to build out the entire system. Leveraging other opportunities need to be considered. It is anticipated that the FirstNet grant process will be administered by the NTIA under the U.S. Department of Commerce. NTIA along with the United States Department of Agriculture (USDA) Rural Utilities Service (RUS) administered the ARRA digital grant process of some $7.2 billion.

There is $135 million in Public Law No: 112-96 for NPSBN implementation planning for the states. An additional $7 billion is available for the actual digital buildout. Wireless 4GLTE Spectrum has also been allocated and assigned to public safety

The FirstNet funding creates an enormous opportunity for Arizona to advance its public safety interoperable network and additionally its digital middle mile in rural Arizona for education, health, government, individuals and business by leveraging SB 1402 which creates two highways for (nearly) the price of one.

Recommendation #10: ENERGY AND THE ENVIRONMENT

Support the leveraging of digital capacity to reduce/optimize energy consumption and protect the environment

Advanced digital infrastructure can enable Arizona to move on the path of sustainable economic development, reducing and optimizing energy consumption and protecting the environment for current and future generations. Reduced energy consumption will not only save consumers and businesses money, but the reduced oil and coal consumption will also provide cleaner air for Arizona residents. The digital infrastructure can provide these benefits by two means: 1) substitute telecommunications for travel; and 2) enable the creation of the electric utilities' "smart grid" of the future.

Sufficient digital capacity will allow individuals and organizations to substitute telecommunications for travel via telework, distance learning, online shopping and e-commerce, remote healthcare practices, and e-government. (Engebretson, 2010)

The electric power network can be modernized to become a smart grid that effectively uses renewable solar and wind power for power generation, optimizes electric power consumption by end users, and makes possible the mass deployment of electric and hybrid electric vehicles. The smart grid's objective is to efficiently use traditional and renewable energy resources for electric power generation and effectively manage supply and demand at end-user sites. This includes distributed supply sources such as end-user solar photovoltaic panels, distributed energy storage such as by using electric vehicles' batteries, and demand response from smart homes and buildings. The smart grid will also enable electric utilities to reduce their infrastructure investment costs and enhance overall system reliability.

- ## Encourage telework and mobility capabilities to reduce travel and increase productivity

In a country that has been moaning about low productivity and searching for new ways to increase it, the single most anti-productive thing we do is to ship millions of workers back and forth across the landscape every morning and evening.

Alvin Toffler, Futurist and Author
(http://www.toffler.com/)

"Don't drive to work one day and your (energy) consumption is reduced by 20%, two days 40%, etc.,"….says Chuck Wilsker, President of the Telework Coalition. Now according to a recent survey from TechCast at George Washington University, less than 4% of private-sector employees across the US now work from home, but "that figure could reach as high as 30% by 2019."

Telecommuting and the broader concept of telework is increasingly popular to enable knowledge workers to better serve their modern enterprises. Advances in computer technology and telecommunications now enable employees to work part or full-time from home as well as from satellite offices, special telebusiness centers, or from the road.

Telework resoundingly delivers an important solution to cut down on gasoline consumption and air pollution by reducing the number of trips to and from jobs and other work-related travel. It yields numerous other benefits in improved employee productivity, satisfaction, and retention while reducing costs and improving bottom-line results. These and other benefits serve the employee as well as employers, the community, and the environment alike.

The Telework Coalition's research has shown that, contrary to what many believe, employees who work at home are more productive, retention is higher and recruiting is easier. The rising generation, Mr. Wilsker said, has grown up with mobile technology and they're demanding a more mobile lifestyle. (Bowden, 2012)

Cost analyses, he said, show economic benefits for both sides. Employers save an average of $20,000 a year in office space, overhead, parking and the like. For the stay-at-home employee, who saves not only on gas and wear and tear on a car but also on clothing, dry cleaning, meals and other incidentals, the average savings is $8,000 a year. (Bowden, 2012)

Ms. Rendeiro, a former president of the Global Workspace Association, travels extensively to talk about the changing workplace. "The workforce is moving into the mobile market. We are seeing it more and more," she said. "Large companies are downsizing their real-estate portfolios, using a "work smarter, not harder' strategy. They're telling employees to work anyplace other than the corporate office." (Bowden, 2012)

Energy consumption can be reduced and productivity gains can be achieved in education through eLearning. It is estimated by Harvard Professor Clayton Christensen in his book "Disrupting Class" that half of all high school classes will be online by 2019. Some 3 million K12 students currently take online classes, and Arizona has been a leader in creating online education opportunities in the K12 environment. On the Navajo Nation, there is an automotive technology class that is taught by one instructor by video conference simultaneously to five different remote student locations.

- **Encourage Arizona governments and the private sector to create telecommuting jobs in rural Arizona**

The State of Arizona can provide telecommuting jobs to Arizonans in rural areas that will reduce energy consumption, help the environment, provide support to the local economy and contribute to demand aggregation of services for digital providers.

One of the most adaptable state jobs for home remote sites is customer service for various state agencies. The State of Arizona employs hundreds of Arizonans for customer service positions. In the private sector for example, when consumers call to make an airline reservation the agent is often an individual working from their home connected to the Internet and a reservation system by their company. There are many other state job categories that could be remote jobs for Arizonans working from their home.

Creating such jobs in rural Arizona would be one of the most effective ways the State of Arizona can create rural digital demand aggregation to encourage more digital infrastructure buildout, reduce unemployment in rural Arizona, reduce the amount of state taxpayers' money used for office space and reduce commuting miles and emissions that would help the environment. For example, Yuma County, Arizona often has the highest unemployment of any county in the nation hovering around 25%. Yuma County has an established customer service industry with the private sector.

Outsourcing state jobs to rural Arizonans help the local economies in areas of great need where job availability is limited. Unemployment on some of Arizona's rural Native American reservations is also high. Such a project could be an integral part of the state's strategy for rural economic development.

The software to ensure that workers are utilizing their time appropriately and other metrics to determine productivity are already well developed in the telecommuting industry. The State can leverage these existing resources and begin a telecommuting job effort of its own. A specific number of jobs should be set aside for telecommuting positions in areas of economic need. The State should

provide tax credits to industries that create telecommuting jobs in Arizona and economic areas of need. Arizona already has a large customer service industry that it can build on.

- ## Facilitate the expansion of the use of e-government at all levels of government

More and more government services are available through the Internet to the citizens of Arizona reducing the need to travel by automobile and corresponding emissions. Arizona has actually been a leader among the states in using digital access to obtain government services, and has also privatized some government services that also use digital access.

Up until the first quarter of 2010, Arizonans in rural parts of the State had to drive hours to a state office location to obtain hunting or fishing licenses that today are available online. Driving school classes are available over the Internet. Creating a business entity can be done from one's home office computer. It also costs government less to provide an online service than to do a transaction in person saving taxpayers' money. Reducing consumers' driving hours can even save additional taxpayer funds by reducing the amount of wear and tear on highways increasing their life of use, and the costs needed to repair and replace them.

The ADOA ASET office does strategic IT planning for state government. A bold and audacious goal for ASET is to eventually provide to all Arizona citizens online digital government services that are available anywhere and at any time to every Arizonan. (ASET, 2012) To accomplish this goal Arizona, including rural Arizona, needs the digital connectivity to make it possible.

- ## Encourage the adoption of digital smart grid applications

A number of insights for the smart grid section came from an interview with Andres Carvallo in June 2012. Mr. Carvallo was chief architect of Austin Energy's deployment of the first version of smart grid in the U.S., and is the author of "The Advanced Smart Grid." He is currently executive vice president and chief strategy officer of Proximetry (www.proximetry.com), which provides network management systems for wireless smart energy networks. (Carvallo, 2012)

The smart grid is a modernization of the electric power network to enable two-way flow of energy and information from the grid to end-user sites. Broadband is needed for smart grid communications between the electric utilities and the various types of digital devices required at end-user sites including smart meters, home/building energy management systems, smart appliances and smart inverters for solar photovoltaic panels and electric vehicles.

Smart meters can provide dynamically-changing electronic pricing information to end users based on the current costs of supplying the electricity, which may vary by time of day based on intermittent solar and wind power supplies. This enables end users to adjust their electricity consumption to optimize their costs based on the pricing of electric power.

Two-way communicating thermostats and in-home energy displays can dramatically drop peak demand by as much as 44%. Smart appliances are being built that use sensors to detect ideal times to operate. Such thermostats and appliances could even be controlled by a cell phone. At peak demand, higher-polluting energy generation sources have to be used more. Dropping peak demand allows utilities to choose alternative non-polluting sources of energy when they have a diversity of power supply.

End-user solar rooftop panels can be used to supply electricity to the home and building or supply and sell electricity back into the grid for general use. Electric and hybrid electric vehicles contain

batteries, which can be used to store electric energy when supply costs are low, and also sell energy to the electric utilities when it is not required. These vehicles can interwork with local end-user solar photovoltaic panels to store their electric energy output as well. In this manner, electric vehicles are part of a system that takes maximum advantage of renewable solar and wind power, and thus the smart grid helps enable their mass deployment. Arizona has become a center for the manufacture of solar power units and the use of solar power that is creating many new jobs.

The smart grid is also an effort to configure a national grid system that reduces the infrastructure costs and inefficiencies of power distribution through digitization. For example, there is excess utility capacity owned by utility companies that is used only a few days a year. The capital costs for power plants are enormous and by sharing electricity through a smart grid, major efficiencies and cost savings could be realized. Arizona could be an enormous economic beneficiary of the national smart grid concept. Already, Arizona provides excess energy capacity to neighboring California. A national smart grid would allow Arizona to provide such capacity to other parts of the country (such as the Midwest and East Coast during the winter) from its solar and other power plants.

The ACC is an ideal government body to encourage electric utility power network modernization and incorporation of renewable resource use, such as solar power and wind power, by establishing a smart grid network based on widespread deployment of the required digital capacity in residences and businesses. The ACC should encourage utilities to deploy smart grids by implementing a reward system of incentives and disincentives for non-participation, which would be a superior model to the current rate-of-return regulation that does not encourage utilities to maximize energy efficiency. The RUS should make loans to rural Arizona energy providers for smart grid projects. The State government could also initiate and promote smart grid development.

The ACC should also encourage utilities to provide a computer model to Arizona consumers with real-time information from smart meters so consumers can make wiser choices. A data privacy policy and guidelines will help make this possible for utilities to undertake. Most consumers have no idea what it costs to run their home computer, heating and cooling, refrigerator, dish washer, hot water heater or washing machines. Smart meters can give historical consumption data, real-time energy use and the actual cost of electricity at the moment it is being used. Informed consumers make better decisions.

Some key telecommunications considerations for smart grid development are wireless spectrum availability, telecommunications service provider offerings to enable smart grid services and security guarantees.

The 700 MHz spectrum, which is appropriate for smart grid applications, is intended to be allocated to public service entities. Utilities could partner with public safety agencies in lobbying the federal government for use of part of this spectrum. Telecom service providers need to be encouraged to offer services and pricing that would be efficient for smart grid deployment. This includes telemetry-type pricing for small bursts of data from end-user smart grid equipment, and MultiProtocol Label Switching (MPLS) VPN services with quality-of-service and security for mission-critical utility applications. The MPLS VPN services could be more cost-effective for utilities than dedicated fiber backhaul. Utilities and the National Institute of Standards and Technology have proposed comprehensive security standards for smart grid communications. The Department of Homeland Security may take responsibility for overall cyber-security issues. The State of Arizona should promote regulations to ensure that consumers can view required data on their energy consumption.

The ACC can also influence utility regulated rights-of-way policies that could allow for digital backhaul through multi-utility trenching that would include fiber cabling. Utilities should be allowed to install fiber optic cables along their power line trenches for backhaul needs. This could be

coordinated for the needs of power, telecommunications, water and natural gas.

In addition, Arizona is an emerging state in the development and manufacture of smart grid equipment and software applications. (Hottenstein, 2012) The State government can encourage the development of business opportunities for small businesses in Arizona that provide smart grid equipment and software for end-user sites and utilities.

Digital Arizona: The Way Forward

In this strategic plan, we envision the long-term benefits of digital capacity development for the State of Arizona. Digital infrastructure is a key foundation for the development of the State in the future. It will transform education, healthcare, and research, improve public safety and government operations, create major new opportunities for business and employment, reduce energy consumption and protect the environment, and generally enable a long-term future of sustainable economic development. These benefits will be shared by every resident of Arizona now and in the future, and will very positively impact the nation as a whole.

We have emphasized the most cost-effective, flexible approaches to build this digital capacity infrastructure. Arizona needs to remove barriers and develop public policies and market-driven strategies that encourage private-sector investment to provide cost-effective high-speed broadband Internet access and advanced digital services throughout the state. Our primary strategy is to enable the private sector to provide the digital infrastructure and services, but public funding may be required where the private return on investment is not sufficient for this to occur.

We believe the long-term benefits to the State and nation will greatly outweigh the costs of the digital infrastructure and services, and we will attempt to quantify the long-term benefits and costs for sample rural community models in the near future. Given these statewide and national benefits that go far beyond traditional telecommunications services markets, we believe there is a strong case to be made for state and federal government funding to support communities in developing the required digital capacity infrastructure and corresponding services. This will be an investment in Arizona and the United States that will yield immense societal returns for current and future generations.

To meet these objectives, public and private-sector stakeholders should undertake a comprehensive plan, comprised of ten recommendations, which will strengthen the foundation for a 21st century economy. Advancing Arizona's global leadership is a task that will be shared by government, entrepreneurs, philanthropists, industry, educators, researchers, and community institutions. Together, stakeholders should implement these ten recommendations, which form a comprehensive plan to build a 21st century economy.

Next Steps

Sample Rural Community Models

The DAP will establish sample rural community models to demonstrate the broadband networking applications and quantify the long-term benefits and costs for these communities.   As discussed in Recommendation 1, a prioritization matrix has been developed to support the evaluation and prioritization of DAP demonstrations and the subsequent statewide buildout staging process.

Summary of Action Items for ASET and DAC

The coordination of all these action items detailed in Recommendations 1 through 10 belongs under the DAP which implements the $6.3 million federal digital grant on behalf of the State of Arizona. This planning project is under the state CIO's office within ASET. This project office should reach out to the appropriate responsible entities under the action items listed above and coordinate the overall effort to improve digital connectivity for Arizona.

The key initiatives that DAP can undertake to advance this strategic plan include:

- Work with ADOT to deploy fiber implementing SB 1402

- Establish sample rural community projects to demonstrate the broadband networking applications and quantify the long-term benefits and costs for these communities

- Advance right of way best practices for state and local government to reduce costs.

- Work with FirstNet to support cost-effective buildout of rural digital infrastructure for public safety and possibly other uses.

Federal Government, State Government, Private Sector Funding Options

Various federal government, state government, and private sector funding options should be considered to realize the full implementation of this strategic plan. These are summarized below:

- Using the State's universal service fee and reforming the federal universal service fee to apply to all telecommunications services and to be used to build the state and nation's next-generation digital infrastructure.
- Expanding the federal government eRate program for telecommunications services and digital equipment for schools and libraries.
- Creatively using federal FirstNet public safety funding to support cost-effective buildout of rural digital infrastructure.
- Instituting state tax credits for service providers' rural digital buildout.
- Rewarding electric utility companies that use emerging energy-saving broadband technologies for smart grid implementations.

This strategic plan should be revisited on an ongoing basis and revised as needed to meet the dramatically changing world of digital capacity and the changing and improving applications that come from it.

Appendix A: Digital Availability and Adoption in Arizona

NOTE: For more detail see the Expanded & Reference version available at
http://www.digitalarizona.gov/Digital_Arizona_Council/Strategy.html.

Accurately knowing the conditions of broadband availability, its capacity, and deficits in all parts of our State, especially underserved rural areas, is critical information for decision-making and informed policy. Because the ASET Broadband Team including the Arizona State Land Department and contractor Data Site Consortium, Inc. has now spent over two years developing the Arizona Broadband GIS Survey and Assessment data, tools, and deliverables under a National Telecommunications and Information Administration (NTIA) Broadband Mapping grants, we can now begin to identify the actual availability and deficits in the State, on behalf of Arizona's broadband stakeholders and policy makers, with a reasonable degree of accuracy.

There is still much to do to make the data yet more accurate and useful to stakeholders as the data currently provided by service providers currently may overstate actual availability in two dimensions. First, for wire line services, availability is frequently shown as availability throughout an entire service territory and does not show in which streets, census blocks, and neighborhoods where physical plant is not actually available to connect all users. Second, as agreed with service providers, download and upload speeds for all types of services are reported as maximum advertised speeds. Digital providers have natural concerns for providing the exact location and diminution of digital middle mile assets for competitive and also security reasons.

The numbers vary considerably when compared to actual speeds experienced by users in most instances. To address these issues, so as to provide more accurate data to our stakeholders, we have a robust verification program using licensed databases, crowd-source data, and speed-test data captured by independent third parties. As the amount of this data is accumulated to a statistically significant level, we will begin to incorporate it in our broadband maps and analysis. We will also continue working with our service providers to obtain more granular and accurate service availability data wherever possible.

The current NTIA Broadband Mapping grants run through 2014 and it remains uncertain whether any federal support for the states' efforts will be provided after that. So, if Arizona wishes to continue with its broadband data collection, mapping, and analysis efforts after that time, plans must be put in place and resources found to support its continuation.

Arizona Digital Landscape and Situational Analysis

From the Arizona Broadband Analysis Project funded by NTIA grants we know that while a healthy 99.5% of Arizona households can get broadband of at least 768 Kbps download from at least one provider. As we move to rural areas that decreases to 97.6% of households. And for sparsely populated rural areas, the percentage decreases further to 95.7% of households leaving just over 4% of sparsely populated rural households without any broadband coverage at all.

When we consider the more reasonable modern connection speed of at least 3 Mbps download, the availability percentages start to visibly decline to 96% of households statewide, 82% for rural areas, and 72% for sparsely populated rural areas leaving some 28% of households in sparsely populated rural areas without what we would consider adequate bandwidth. At a somewhat higher connection speed of 6 Mbps download, the availability percentages more precipitously decline to 94.0% of households statewide, 72% for rural areas, and only 57% for sparsely populated rural areas leaving some 43% of households in sparsely populated rural areas without such higher performance services.

Looking at specific technologies, cable modem services at connection speeds of at least 3 Mbps

download are available to 89% of households statewide, 56% for rural areas, and 35% for sparsely populated rural areas. The cable industry has invested heavily in a new generation of DOCSIS 3.0 services to be able to deliver connection speeds of 10 Mbps download or greater to 79% of households statewide, but that percentage declines to 47.0% of rural households and only 30% of sparsely populated rural households.

Mobile wireless services at connection speeds of at least 768 Kbps download, generally 3G services edging into 4G, are available to 98.8% of individuals statewide, 94% for rural areas, and 90% for sparsely populated rural areas. At connection speeds of at least 3.0 Mbps, well into 4G service range, mobile wireless services are available to only 79% of individuals statewide and a meager 21% of those living in rural areas. See the more detailed tables that follow in Appendix A for an expanded view.

ATI Institute partnered with Microsoft Corporation and their Shape the Future team to have a Digital Inclusion Economic Impact Model for Arizona undertaken by their partner, The Arnold Group focusing on disadvantaged school-age children and their families. Arizona modeling results indicate that students with a home PC and broadband access increase their chance of graduating from High School by 6-8 points and increase an average of $1.2M additional economic and social impact over their lifetime. The affected individuals will also have more employment opportunities benefiting from significant lifetime creation of jobs. By targeting students in poverty, over $32.4 billion in total lifetime economic and social impact can potentially be realized.

Digital Adoption: How Does Arizona Compare?

The US Census Bureau reports Computer and Internet Use in the United States from 2010 in depth on their site at http://www.census.gov/hhes/computer/publications/2010.html. The data reveals Arizona ranks 18th among the 50 states and the District of Columbia in coverage with with 79.1% of Arizonans living in households with Internet access. Arizona ranks 31st in individuals accessing the Internet at home at 64.6%. Arizona ranks 15th in Individuals with a household computer at 84.2%. Finally, Arizona ranks 24th with 40.4% of individuals in the state having access to the Internet from a location outside their home. A summary of Arizona, average, top ranked, and bottom ranked State statistics are included in a separate page below.

Akamai Technologies is the leading global service provider for accelerating content and business processes online. Akamai utilizes data gathered across their global server network, which serves an estimated 20% of the world's Internet traffic, to provide continually-updated visualizations of global Web traffic and performance. In their most recent reporting for Q2 2012, Arizona ranks 45th among the 50 states and the District of Columbia with a 4.8 Mbps average speed experienced by broadband subscribers compared to top ranked Delaware at 12.1 Mbps and bottom ranked Missouri at 3.6 Mbps. For average peak speed, Arizona ranks 48th with 19.7 Mbps compared to top ranked Delaware at 41.6 Mbps and bottom ranked Missouri at 15.7 Mbps.

For overall broadband adoption of over 4 Mbps, Arizona ranks 44th among the 50 states and the District of Columbia with 43.2% of the population utilizing such services compared with top ranked Delaware at 94.2% and bottom ranked Arkansas at 30.1% and has realized a 24% increase in over 4 Mbps subscribership from 34.7% in Q3 2007. For high broadband adoption over 10 Mbps, Arizona ranks 43rd with 8.1% of the population utilizing such services compared with top ranked Delaware at 38.8% and bottom ranked Arkansas at 3.0% and has realized a 135% increase in over 10 Mbps subscribership from 6.0% a year ago and a 450% increase from 1.8% in Q3 2007.

Further details and comparisons can be found in Appendix A of the Expanded & Reference Version.
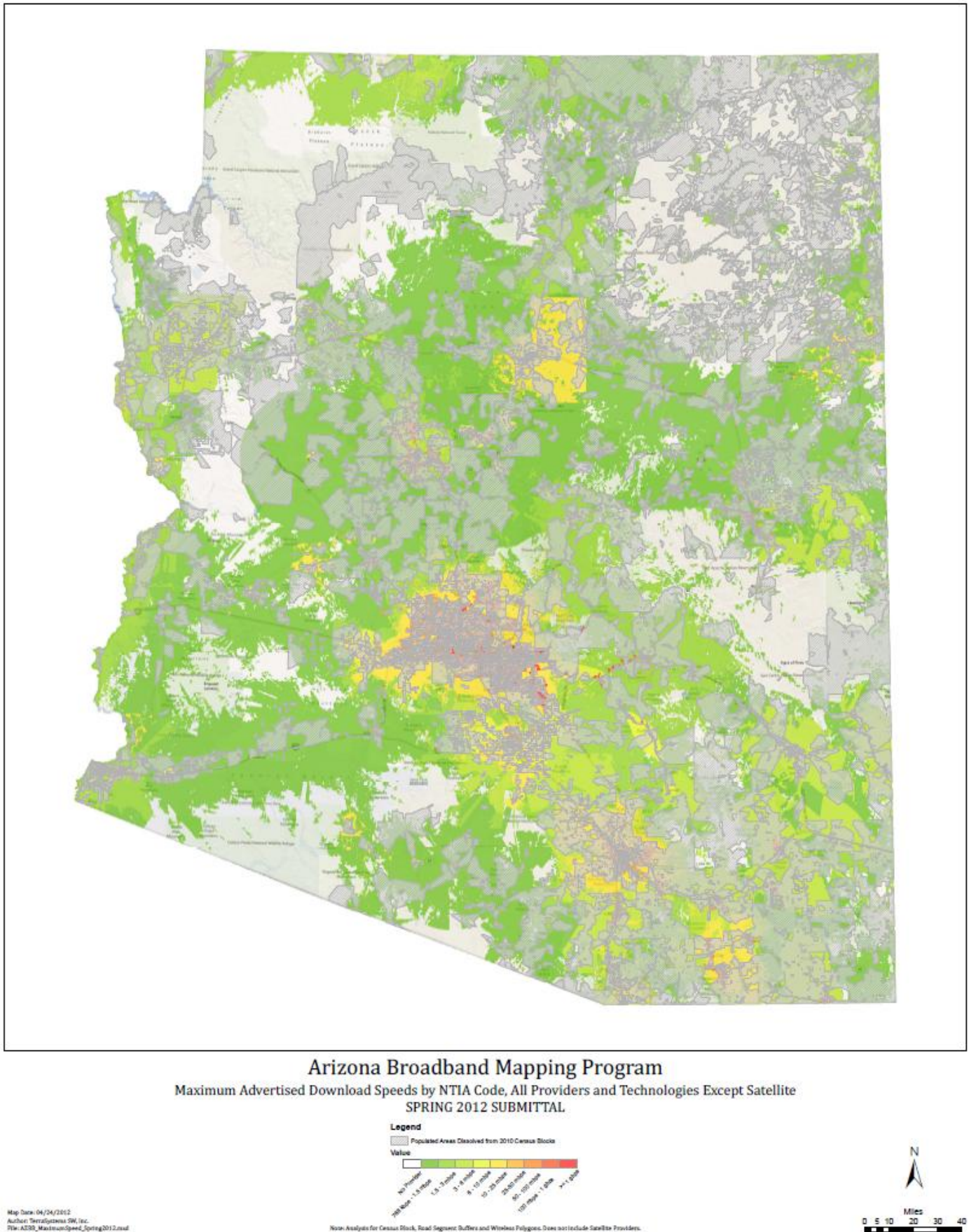
In another study, Arizona currently ranks 34th among fifty states in average digital connection speeds. Our neighbor California ranks 8th, Nevada 9th. Delaware ranks 1st and Utah 2nd. (Woolley, 2011).

Figure 13: Arizona Broadband Provider Counts (Minus Satellite)

Arizona Broadband Mapping Program
Provider Count (unique FRN's) - All Technologies and Spectra Except Satellite
SPRING 2012 SUBMITTAL

Populated Areas Dissolved from 2010 Census Blocks

Value

1 | 2 - 3 | 4 - 6 | 7 - 9 | 10 - 11 | 12 - 17 | 18 - 21

Map Date: 04/23/2012
Author: TerraSystems SW, Inc.
File: AZBB_ProviderCount_Spring2012.mxd

Note: Analysis for Census Block, Road Segment Buffers and Wireless Polygons. Some FRNs have more than one reported technology and/or spectra. Does not include Satellite Providers.

Miles
0 5 10   20   30   40

Figure 14: Maximum Advertised Download Speeds (Minus Satellite)

Arizona Broadband Mapping Program
Maximum Advertised Download Speeds by NTIA Code, All Providers and Technologies Except Satellite
SPRING 2012 SUBMITTAL

Legend

Populated Areas Dissolved from 2010 Census Blocks

Value

Appendix B: Digital Capacity Resources

NOTE: A subject index to the titles and URLs that can be found in the Expanded & Reference version available at http://www.digitalarizona.gov/Digital_Arizona_Council/Strategy.html.

Federal Resources

State Digital Capacity Plans and Resources

Arizona State Resources

National Nonprofit Organizations

National Trade Associations

Arizona Nonprofit Organizations and Trade Associations

National eLearning and Technology in Education Resources

Arizona eLearning and Technology in Education Resources

National Telehealth Resources

Arizona Telehealth Resources

National eGovernment Resources

Arizona eGovernment Resources

National Discovery, Innovation and Research Resources

Arizona Discovery, Innovation and Research Resources

National Smart Energy and Environmental Resources

Arizona Smart Energy and Environmental Resources

National Public Safety Communications Resources

Arizona Public Safety Communications Resources

National Native American Resources

Arizona Native American Resources

Arizona Statistical Resources

Community Toolkits, Economic and Financial Modeling

Miscellaneous Resources

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